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THE SCAMMON LECTURES
AT THE ART INSTITUTE
OF CHICAGO

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The lectures are known as
The Scammon Lectures.

LITHOGRAPHY FOR ARTISTS

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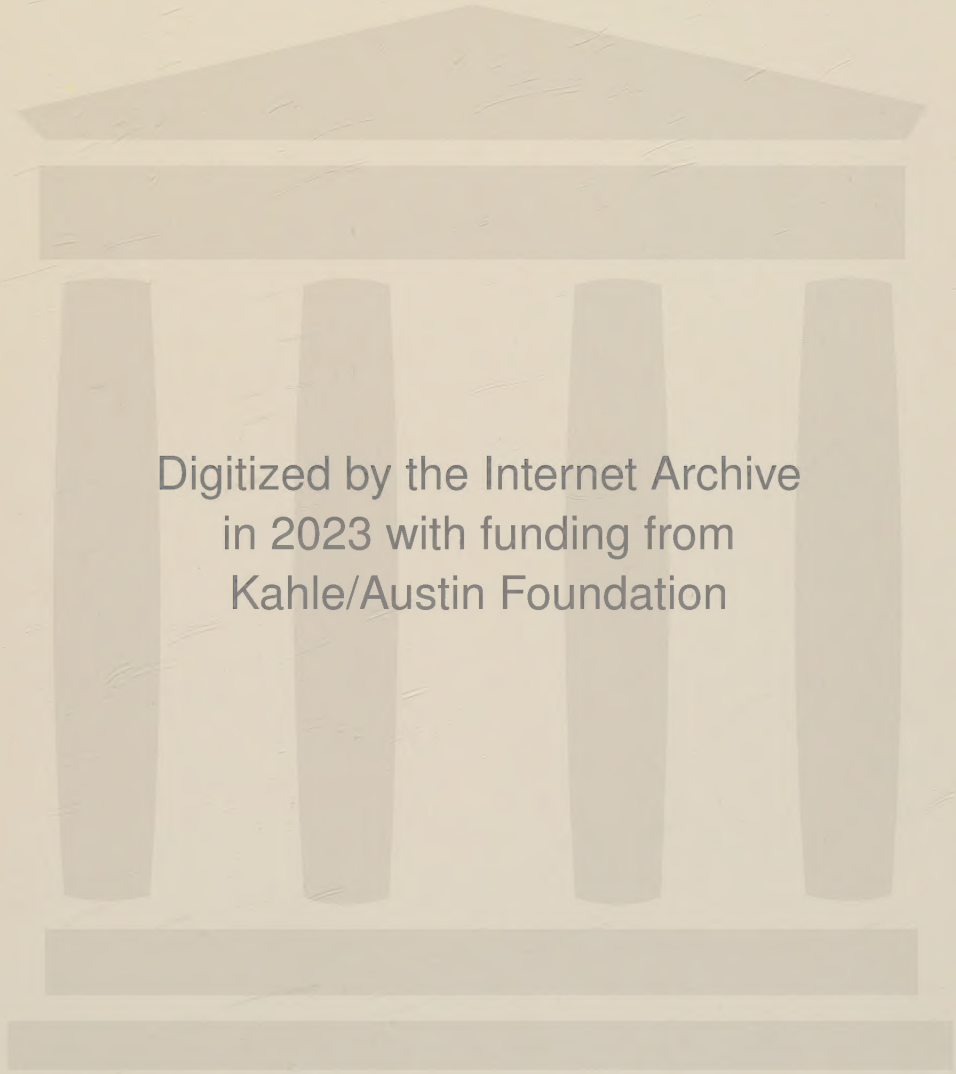
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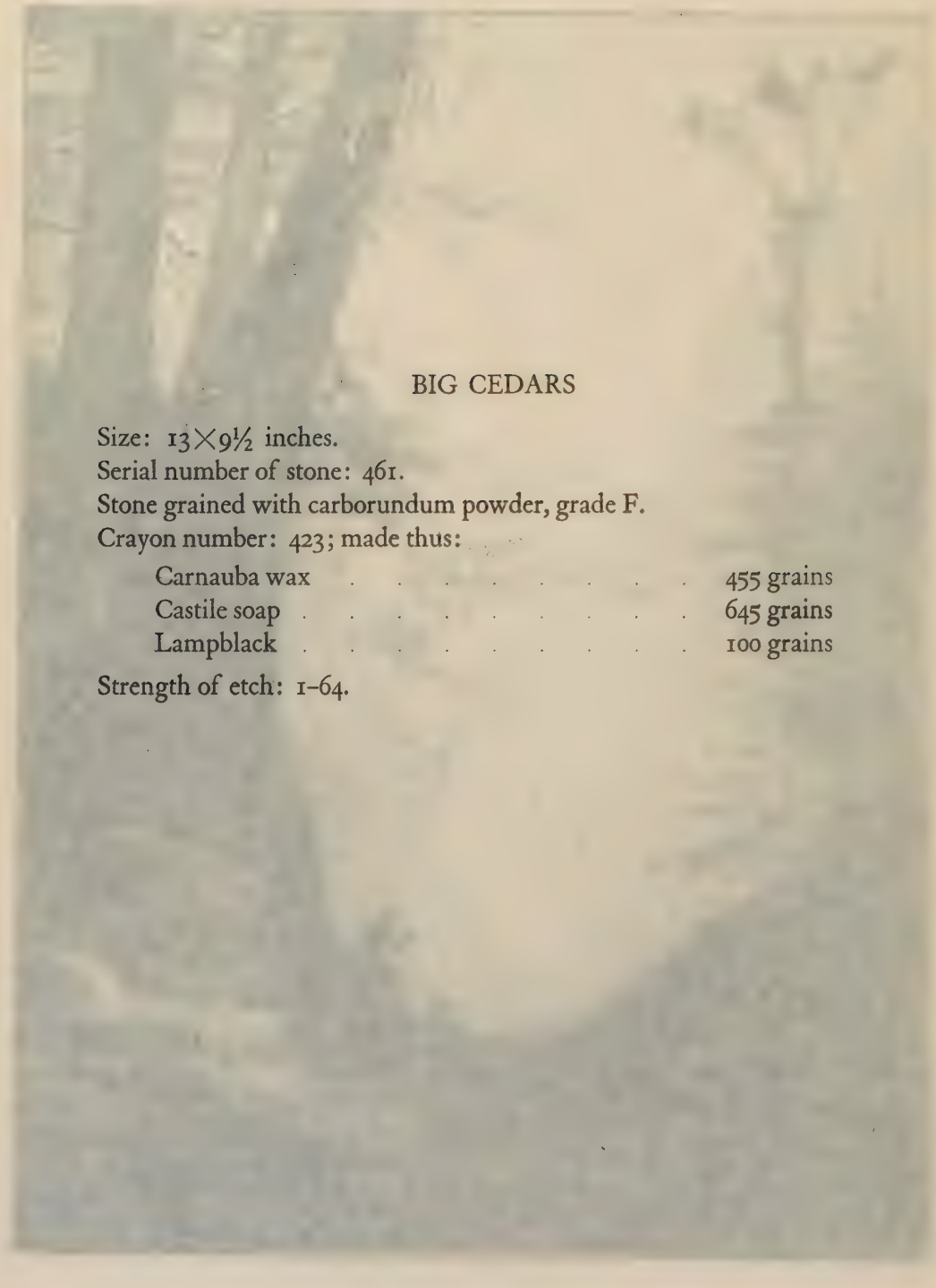
BIG LEDGERS

Size: 19½×9½ inches.
Serial number of stone: 497.
Stone grained with carborundum powder, grade F.
Crayon number: 453; made thus:

Carnauba wax	455 grains
Castile soap	645 grains
Lamphblack	100 grains

Strength of etch: 1–64.



BIG CEDARS

Size: 13×9½ inches.
Serial number of stone: 461.
Stone grained with carborundum powder, grade F.
Crayon number: 423; made thus:

Carnauba wax	455 grains
Castile soap	645 grains
Lampblack	100 grains

Strength of etch: 1–64.

LITHOGRAPHY FOR ARTISTS

A COMPLETE ACCOUNT OF HOW TO GRIND, DRAW UPON, ETCH, AND PRINT FROM THE STONE, TOGETHER WITH INSTRUCTIONS FOR MAKING CRAYON, TRANSFERRING, ETC.

By BOLTON BROWN

THE SCAMMON LECTURES FOR 1929. PUBLISHED FOR THE ART INSTITUTE OF CHICAGO BY THE UNIVERSITY OF CHICAGO PRESS, CHICAGO, ILLINOIS

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PREAMBLE

IT IS suggested that one who puts out a technical book should begin by telling his public reasons why it should believe what he says. Reluctantly conforming to this, I will say that I was trained as a painter, also as an etcher, and have paid in time and labor the price necessary to the mastery of the operations involved in both the art and craft of crayonstone lithography. Here is brought into co-operation an artist's lifelong familiarity with artistic problems and a technical grasp of the craft side of the matter—from graining the stone to flattening the finished proofs. The British Museum has a practically complete set of my prints, presumably as works of art; while in the offices of the heads of several of the best lithographic firms in New York they also may be seen hanging, bought and placed there as examples of craftsmanship. For a year I worked with my stones and presses in London. Then I brought them over to my present home at Woodstock, New York. Here I have gradually rounded out a sufficiently complete equipment. Here it is that I have done my private work, and here people sometimes come to study with me. Here in 1919 I put out what I think was the first published offer in this country to teach artistic lithography. When I go down from this rustic retreat to New York, it is generally to work for the rest of the world—write, lecture, print, exhibit—whatever comes up to be done.

As I have worked—making my own lithographs I mean—I have kept up a continuous and extensive experimenting with a view to subordinate to my purposes various new substances and methods. The bulk of the information thus obtained has had only a negative value; but in a few instances, important inventions of interest to artists generally have resulted. I have not, however, in cases where these are incorporated in succeeding chapters, thought it worth while to cumber my pages with a continual patter of remarks as to how this or that formerly was, or now is, done by others. Anyone who wants to may do this; and it would be of interest, for sometimes the new usages vary so widely from the old as to constitute almost a new art.

Indeed, when working thus, solely for my own artistic aims, I have found this almost-new lithography more rewarding, more tempting to new fields, more certain of getting results, more lovely in results when got, than I ever dreamed was possible when I began.

Probably that particular new contribution which can be most readily appreciated is the one which puts into our hands a power, somewhat like that of the plate printer, to get tints and tones and richnesses by manipulations of oil and draggings of ink on the copper plate. The lithographic achievement of analogous results is entirely new. The results it is, not the process, which are analogous, for you cannot smear your ink and oil on stone as you can on copper. The means are unique, but the results are a richness suggestive of charcoal, mezzotint—effects of great beauty, and, as I said, not hitherto obtained, or possible, in lithography.

That I have written in a highly condensed and, from a literary point of view, unrewarding style is explained by the fact than any other style would have led on to a book of quite impracticable dimensions. Lithography has been to me for so many years a matter of purely personal adventure, full of the ups and downs that give fascination to any adventure, with high times of success and low times of black failure, that were my purpose other than to bottle up the maximum of facts in the minimum of space, I might have thrown it into the form of a personal story. Early and late I have plugged along, drawn always by something that was just eluding me—something, in the midst of dirty clothes and calloused hands, shining and beautiful. Sometimes it has been one thing and sometimes another; but always it was just beyond, to be captured and embodied tomorrow or next week or next summer. And when I have gone abroad and met and visited with professional printers, it has pleased me to find that, bound though they were to the chariot wheels of commerce, they, as well as I, experienced something of this glamor, something not quite to be explained—a sense of undiscovered possibilities, it may be. One said—and he had grown gray with the roller in his hands—"Oh, you will always keep finding out new things." And for that I loved him, and our craft.

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I. INTRODUCTION

* * * *

BOOKS telling how to make an etching have been published in considerable numbers; but of works intended to enable an artist to make a lithograph, with his own hands, there exists not one.

Not only is there this absence of books, but there is a scarcely less complete absence of artistic printers. The genuine professionals are tied up inside huge commercial establishments where they cannot as individuals—nor can their employing firms, with profit to themselves—undertake printing for artists. In these establishments everything is subordinated to speed, cheapness, and quantity production. Consequently, for the man who is simply the artist, who has drawn something lovely on a stone and wants thirty fine proofs of it, there is not in their world any place at all. Besides, it is only the very unusual commercial printer who, bred on and fed by commercialism, possesses that combination of artistic sense and technical and manual skill which works of art demand.

In the early days of lithography it was the business man, the publisher, who exploited it; and such a conception as that a private artist should set up and with his own hands serve his own press never entered anyone's head. Had the suggestion been made, it would have been met by the objection that printing, unless it had been learned by a long apprenticeship in the regular way, would be too difficult for the artist. Beyond this it would have been said that the artist ought not to spare the time necessary to print what in those days would have been thought of as normal editions—editions of hundreds and of thousands.

We of today have brought in a different principle. We work with the idea that there is always room at the top and that tops are small. Instead of the rapid production of large numbers of middling prints sold cheap, we who specialize on fine prints substitute the slow and careful production of a few superb proofs sold high. This is an entirely different conception. And by it the artist can be his own printer and the printer be his own artist, which happens to be the only arrangement compatible with the finest achievement in both lines. It is because the production of lithographs in this way did not

exist in the past and has but just begun in the present that I am sure the future is destined entirely to eclipse all that has gone before.

Our ancestors fought bloody battles with bows and arrows: we accomplish destruction otherwise, and these old tools of death are to us merely things of pleasure and discipline. The camera used to be only for the professional, but now it is everywhere—a means of personal expression. So in any number of instances it is the same. Among the fine arts, under the special culture of the amateur enthusiast, there blossoms here and there a higher sort of thing, carrying a previously unrecognized and unrealized cultural significance.

I offer this book to my fellow-artists knowing that none can get out of lithography all there is in it unless he does his own printing—and does it fully understanding the resources of the craft. And this reminds me to say that the idea in some artists' minds that lithography is primarily a thing for hasty sketches is wrong. Of course you can sketch and skirmish on stone—quite perfectly—nowhere more so—but to set this as the first thing is to run the chance of forgetting the more important fact that it is even more suited to work that is thorough and complete. There are circles in which it is the fashion, just now, to seem to see in mere scrawls virtues hitherto hidden from mankind. But the nature of the human mind has not changed because the excessive multiplicity of mechanical reproductions of hasty things has affected some persons' taste. There exist everywhere in the mob individuals who are not "mobized," who are able to enjoy other than the snapshot mood. There are among the artists those whose nature it is to create thoughtful and complete works.

Let me try to suggest what I am thinking, by saying that sometimes the creative imagination works by flashes and records by jots—but not always. There are times when it acts ruminatingly, even dreamily. Our thoughts are necessarily clothed with the complete values and the defined and solid forms of nature, and sometimes the artist feels like going very far in realizing his values and forms. And when he does want to draw a relatively complete picture—complete in this sense—drawing on stone is marvelously suited to his need. It will accept any degree of elaboration and will give it unharmed in the print. I wish that Corot had drawn for us on the stone some of his landscapes, with all their beauty of tone. The prints would not have disappointed him, and the world would have been the richer. If Inness could have worked on stone—not just casual experimentation, but could

have really got used to it—what things we should now be treasuring! If today someone who can make beautiful drawings of the nude were to create a series on stone, it would be a very fine thing—and no one has done it. And for portraiture—the opportunity is obvious.

It is true that there are already a few artists—very few—who have in their studios lithographic presses and who print occasional impressions from their own stones. But for the most part even these men, with the machinery all around them, if they want an edition made, call in the professional printer. They discover that there is a difference between pulling an occasional experimental impression and printing an edition. The function of all printing is to multiply, and etching and lithography are both methods of making prints. If a man is not able, by printing, to multiply his work into reasonable editions, he is not in practical command of the craft. He may, just as anybody may, pull a proof—or, more correctly, an impression, for only a skilled printer can *prove* what a stone can do. But, as I have said, unless he can get the best the thing is capable of, and can keep on doing so through an edition (and I know of no artist in this country except myself who claims to be able to do this), he is not getting out of the process that for which it exists.

Among the etchers, printing one's own plates is a very usual thing. But there are differences between an intaglio plate and a flat stone. The most important one is that the stone is much the easier to injure. Again, pulling a print or two is a different thing from pulling an edition. The act of printing, if it is in the least mismanaged, easily injures, even ruins, the design. Pulling an edition requires a mastery of the physical and chemical operations—of the acids and gums, of varnishes, inks, temperatures, dampnesses, pressures, backing-boards, printing paper, abrasives, solvents, etc.—sufficient to enable the printer to go on using the complex machine which these constitute, until the edition is complete. This, though rather more than is demanded of the etcher, concerning whom I speak advisedly, for I am an etcher myself, is by no means an impossible demand.

It would have afforded me much satisfaction to illustrate this work by examples chosen from the work of great men. I should love to get out a book just devoted to them, as works of art. As a contribution to the history of artistic achievement it would be a worth-while thing to do. But my present subject is not these achievements that artists have accomplished by means of the process but—quite a different thing—the process itself.

And if I were to bring in here illustrations from Prout or Gavarni, I should be but confusing myself and the reader by just this common confusing of the product with the process. In the dictionary sense, in fact, neither Prout nor Gavarni was a lithographer, for they did not print from the stone, or print at all. This was done by specialists—printers, correctly called "lithographers." The artists were lithographic draftsmen. So, if I were to illustrate a treatise on the art of drawing and printing from the stone by designs from Harding or Daumier, there would always be this misleading element present. The men named could at best but illustrate the method of drawing, while nobody knows anything about the men who actually made the prints the public sees. Their very names are lost, masked under that of the firm that employed them. But since I became a craftsman myself and learned, by doing the same things, the difficulty and the importance of the part these nameless ones played in the proceedings, I have come to have a high respect for them.

If I had one of these printers beside me and if I could take up a particular lithograph which he had etched and printed and could learn from his own lips the exact steps he had taken to produce it, I should assuredly publish them, the design itself, and the names of both artist and printer. Having no such opportunity, I am quite unable to give of, say a print by Bonington, any such exact account of the mechanisms of its production as would enable the reader to utilize them in lithographs of his own. To do anything like this I am, whether I like it or not, forced to fall back on my own work, where I do know, quite exactly, just how every step of it was done, and can give an account of these steps. I hope that this explanation will make clear why this book is not illustrated by designs by men whose names are known all over the world.

I would like to be allowed, here where I am not tied down to technical matters, to discuss for a moment one or two things about lithography in general which seem to me to need discussing. In the first place, there is a universal looseness in the word "lithography" itself—a thing that has very likely come about because so much that is new has come into the art since its name was first applied to it. Etymologically it means drawing on stone, although we all know that not the stone but the opposition of grease and water is the essential matter. The same method may be used on other surfaces, and Senefelder merely adopted stone because it combined the greatest number of advantages. The commercial lithography of our day has found

reasons, none of them artistic ones, for replacing the stone with zinc, glass, aluminum, rubber, and so on, turning out an enormous mass of widely diverse prints all of which, according to the loose terminology above referred to, are "lithographs." A term that includes so much necessarily defines very little, wherefore the technical journals are now substituting, for all applications of the Senefelder process, regardless of the surface used, the word "planography." Of planography, lithography thus becomes a subdivision.

Originally the field of planography was limited to that of lithography, at least in artistic printing, for before photography came in and the process block, practically all artistic planographic printing was done from stone, and from drawings made directly thereon, with crayon. Throughout all the great historic period of lithography this was the procedure.

I mention crayon thus specifically because it, above all others, is the art that has made history. Other ways there are, as I just said, to make designs: there is the brush and the pen, carrying ink; and Senefelder describes quite a list of "methods"—stumpings, scrapings, engravings, and so on—all of them obviously available and all having been available these hundred years; yet the history of these years, as deduced from the usages of the ablest lithographic artists, is that these things one and all are of little importance compared with the great basic "method" of taking up a piece of crayon and making marks with it.

"Drawing" has been defined as making significant marks, the significance being in proportion to the draftsman's control of his hand and to the clearness of the record thereof. Various substances falling comprehensively under the name of crayon have been acceptably used by great men—charcoal, graphite, chalk, pastel, Conté crayon, and lithographic crayon. Of these, the last is peculiar in that it alone was deliberately and artificially invented with a view to its use on a pre-existing and definite surface. Of course it will make marks on other things than stone, but on none of them will it make marks that are so excellent.

An art so important as this deserves a name that shall not be ambiguous, that shall include what it is and exclude what it is not. Since it is simply crayon on stone, we have but to condense this a little and we have our word—crayonstone. Then, just as lithography is a division of planography, crayonstone is a division of lithography. With this long-needed addition to our vocabulary we can without circumlocution indicate the important class distinction between a drawing done on stone and one done first on paper

and then transferred to another surface and planographically printed. The former, by this nomenclature, would be a crayonstone lithograph; the latter, if transferred to stone, would be a transfer lithograph, or, since these works are often transferred to zinc or other substance, a transfer planograph. For ordinary usage, however, the two simple words "crayonstones" and "transfers" embody all that is necessary.

Isabey, Bonington, Duzats, Ciceri, Géricault, Haghe, Mouilleron, Gavarni, Boys, Prout, Harding, Daumier, and their associates produced crayonstones and not transfers. Writing in England, in 1919, for a special number of the *Studio* entitled *Modern Woodcuts and Lithographs,*[1] Mr. Malcolm C. Salaman states that those among contemporary artists who accept crayonstone as the superior to transfer include "all our distinguished lithographers," of whom he names Brangwyn, F. Ernest Jackson, Kerr Lawson, Sullivan, Becker, Hartrick, Spencer Pryse, John Copley, Ethel Gabain, and Belleroche. Mr. Belleroche writes to Mr. Salaman that transferring is "handy for rough sketches" but that "a good drawing will certainly lose all its savour after it has been subjected to the transfer operation." Here in America, Albert Sterner, John Sloan, Chauncey Rider, and George Bellows would agree with their transatlantic brethren.

And I agree with them; but not because I do not know how to value transfer. I am an expert transferrer, and in this book the operation is taught; but as an artist I work almost exclusively on stone. Mr. Pennell, on the other hand (as also, for the most part, Whistler), draws not on stone but on paper, and the prints are transfers. Fantin-Latour's work is a mixture of crayonstone, transfer, and white-line engraving.

For going somewhat into these matters there are several reasons. A leading print dealer said to me that lithography was handicapped in that "the artists are too lazy to draw on stone." A very important exhibition refused to let me catalogue my prints as drawn on stone. Certain interests are advantaged by keeping this distinction away from the public, the collectors, the critics, and such artists as know nothing about it. Where mention of it cannot be quite suppressed, the next best thing is to pretend that it is of no importance. That transfers can have merit no one doubts, but they necessarily lack the larger set of merits which is only possible to crayonstone.

[1] *Modern Woodcuts and Lithographs by British and French Artists.* With Commentary by Malcolm C. Salaman. Edited by Geoffrey Holme. London, Paris, New York. The Studio, Ltd., 1919.

Hence, when Mr. Pennell writes in *International Studio,* Vol. 7 (1899), p. 43, col. 2, par. 2, that "you can do anything on paper that you can do on stone," he writes mistakenly.

On the general subject of lithography there are some books, a very few. At least there are very few that are in English. Electing to begin with the last of these, we find it to be the book by Mr. and Mrs. Pennell, largely historical, but including a technical part by Mr. Pennell. No one could print with such a roller as he suggests; his statements about the washout contradict universal practice, and to apply an etch according to his figures would destroy the stone instantly.[2]

In the earlier literature of the subject the defect is that the art side and the craft side are not treated with equal authority. In none of them is there any assumption that the artist is going to do creative work and print it himself. They show the artist how to do the drawing but take it for granted that a professional printer will do the printing. In the latter years of the nineteenth century E. Duchatel, of Paris, sent out, in French, his work, *Traité de Lithographie Artistique.*[3]

About 1896 Alfred Lemercier[4] got out, also in French, his very thorough technical monograph as a manual for lithographic artists and printers. Hamerton's *The Graphic Arts* (1882)[5] contains a few sound remarks on lithography, but nothing of more than general interest to the practical worker. In 1891 there was published in French an elaborate manual on all forms of lithographic work, written by a "chemical engineer," M. M. A. Villon. In England in 1919 there was issued the last and revised edition of an excellent trade handbook, David Cumming's *Handbook of Lithography.*[6] In 1914, in London, there came out another excellent work of the sort, *The Art of Lithography,* a *Complete Practical Manual of Planographic Printing,* by Henry J. Rhodes.[7] Richmond's *Grammar of Lithography,*[8] an Eng-

[2] *Lithography and Lithographers,* p. 261, line 3. New York: Macmillan Co., 1915. "Twenty parts of acid to one of water."

[3] En Vente à Paris chez l'Auteur, 8 rue Guy-de-la-Brosse, à la Société des Imprimeries Lemercier, 57 rue de Seine, et du Journal L'Artiste, 44 quai des Orfèvres (n. d.).

[4] *La Lithographie Française de 1796 à 1896 et les Arts qui s'y rattachent.* Manuel Pratique s'adressant aux artistes et aux imprimeurs. Paris: Ch. Larilleux & Cie.

[5] Published by The Macmillan Co.

[6] Original edition issued 1904, London.

[7] London: Scott Greenwood & Son; New York: D. Van Nostrand Co., 1914.

[8] London: E. Menken.

lish work of some fifty years ago, is a very good manual for commercial workers. In 1824 Charles Hullmandel,[9] the English lithographer, published a technical treatise showing how to make on stone a drawing of the kind then in vogue, and in such a way that an edition of the sort then usual could be printed from it. In my earlier stages I got benefit from this book. In 1832 the same author put out his last edition of his translation of Raucourt's excellent French work on lithographic printing; this also is a work of technical value to beginners. The last to be mentioned, though first in time and importance, is Senefelder's own book,[10] translated into English more than a century ago.

[9] *The Art of Drawing on Stone.* London, 1824.

[10] Alois Senefelder, *The Invention of Lithography* (translated by J. W. Muller). New York: The Fuchs and Lang Mfg. Co., 1911.

II. THE STONE

AS ALREADY stated, the principle of printing by the repulsion of oil and water, which was Senefelder's invention and which has been called "lithography," has been found applicable to so many other substances than stone—zinc, aluminum, glass, rubber, iron, etc.—that a wider name is needed for the work done by this method. "Planography," of which lithography is one division, has been introduced. Planography prints neither from a raised surface nor from an incised surface, but from a flat surface whose diversities are purely chemical. A part of this surface, by being treated in a certain way, is made to accept water and refuse grease; the remaining part, treated in a different way, reverses this action, refusing water while accepting grease. These chemical preparations enable the printer, after wetting his surface, to make the ink stick to certain parts without sticking to other parts. This done, a print is got by pressing paper against it. This was Senefelder's invention.

Among all the substances available in planographic printing, stone has from the beginning always held the chief place. It holds it still wherever the first question is the quality of the work. Zinc is sometimes substituted as more convenient; but the work on it is not so good as that on stone, and Mr. Thomas R. Way correctly characterizes it as "lacking the refinement of stone work."

THE STONE

For crayon work the cleanest and most evenly colored stones of extreme hardness are to be selected.

—SENEFELDER

Lithographic stone is of a grayish color with a grain like petrified clay. Fossil shells and other organic remains often occur in it. In chemical composition it is about 97 per cent carbonate of lime.

Various regions of the world yield stones of this character, but as yet it is only from the original quarries at Solenhofen, in Bavaria, that we get those very superior kinds which our art requires. Two chief varieties are

recognized, yellow and gray. The yellow ones are softer than the gray. The latter class is sometimes again divided, the name "blue" being given to the coldest-colored, hardest, and most brittle sorts. For artistic crayon work, blue and gray stones, especially the latter, are preferred. The yellow ones are more easily injured in etching and will not yield so sharp a print.

The stones are grubbed from deep quarry pits in damp slabs of various thicknesses and qualities. Of all that the quarry yields, only some 2 or 3 per cent are sufficiently perfect to be of use to us. The expert overseer picks out the good slabs, marking their grades, those of the best grade being subsequently planed on both sides and marketed at an extra price as double-faced stones.

Some stones show a peppering of red points (iron), and others are marred by the presence of fossils. Still others show broad color bands that are visually undesirable for the draftsman and that contain in some cases a very remote possibility of injuriously affecting the print. Once or twice I have had bars appear in the print corresponding to color bars in the stone. Other stones have seams of what is called "glass." So long as these are closed, as they usually are, most kinds of work may safely ignore them. If they are "open," i.e., if they absorb water and give it out again in a wet line when the surrounding surface is dry, then they are dangerous. The best stones not only are fairly free from defects but show a fracture of peculiar smoothness and evenness.

Since the scraper of the press brings great pressure along a mere line, if the stones were not rather thick the pressure would break them. According to the area of its surface, a stone may have a thickness of from 1½ to 5 or 6 inches. A stone having 300 or 400 square inches of surface—that is to say, one measuring about 18 by 20 inches—may weigh from 50 to 100 pounds. Selected second-hand stones are in no way inferior to new ones. When a stone has worn too thin to withstand the pressure of the scraper, it may be used as a mixing-table for the ink. Or it may be kept in use by reducing its size. If it is rather large and you elect not to trim it down but to cut it in two, this is readily done; or at any rate I do it, as follows: I support the stone on an edge which, on the under side of the stone, follows the line where the break is wanted. Directly above, on the upper side of the stone, I rule a line. A small chisel is set upright on this line and smartly hit with a light hammer. Sliding the chisel along after each blow, I hit again, clear across. If it remains firm, I repeat, listening carefully. Shortly I hear the

clear ring of the stone give place to a dull sound, and know an effective crack is dividing it. A delicate tap causes it to drop apart.

The fractured surface is beautiful. It is almost as smooth as flint, so fine are its component grains. It is not hard, it is brittle and tense, and rings when struck. Since the natural rock has no appreciable texture of its own, we have the opportunity to create upon it by artificial means whatever texture exactly suits our needs.

CRAYONSTONE

DRAWING ON STONE AS A FINE ART

The range of every art corresponds to the physical nature of the substances used. Commonplace as this statement assuredly is, many writers, talkers, philosophers, and aesthetes still do not grasp either its truth or its importance; and naturally, for without sense-familiarity with the substances and processes of an art it is not possible that they should read the minds of the artists whose language these constitute. Pindar said: "To the cunning workman true knowledge comes, undeceitful."

When crayonstone drawing was brought into the world, able artists (1820–60) saw and used it. Being workmen, they sensed the nature of the materials they saw and felt and spoke through. The outstanding character of the crayonstone mark is its granularity, coarse or fine as the stone is. It is peculiarly responsive to pressure. It responds in two ways: by darkening the area pressed upon, and also by increasing its size.

The surface of the stone is made of minute hills and valleys, lying in a plain. The crayon scrapes itself off against the tops of the hills. With light pressure, only the summits get covered, the interspaces remaining relatively wide. The tint thus composed has great fineness, paleness, and openness. Pressure on the crayon increases the size of these grains, adding at the same time many new and minute ones on the summits of those hills that are smaller. The tint is now darker and somewhat coarser. Ultimately, with pressure enough, all the hills and even the bottoms of the valleys are charged with crayon. The tint now is flat black with no texture at all.

As the tone gets darker and coarser, it still retains some refinement, some bloom. This depends upon very small grains of dark among the large ones and upon the presence of very small interstices of light everywhere.

Such is the lithographic tone, a clean sparkling interplay among parti-

cles of white and black. In white paper it does not exist; in flat black it does not. In all the gradations between these, it does.

This is the way it is on the stone. It is the business of the printing to present it thus in the print. If the printing does not do this, it is not good printing. If the etching eats away some of the small granules, the texture is coarsened, the tone is changed in value, the design is injured. If the inking is so handled as to fill up some of the small granules of light, the texture is coarsened, the values changed, the work injured.

Remembering that the hills, valleys, and grains just spoken of may be on any scale of size, according to the size of the grains of the abrasive material used in surfacing the stone, we see that the pictorial range of crayon-stone is practically boundless. Mouilleron reproduced Delacroix's painting so well that this painter thought the print had qualities he hardly remembered putting into the painting. If lithography can do this from a painting, it can do it without any painting. Artists are not limited to mere sketches: they can elaborate as fully as they choose, and the stone will justify them.

In the history of the art, almost every sort of subject and style of treatment has sometime been essayed. Lions, as large as real ones, on billboards, and gnats, as small as real ones, on drawings of fruit, have been successfully dealt with. Portraiture has been done in every conceivable manner; and if the figure has been presented less often, this is not from any shortcoming in the art.

As to contemporary crayonstone work, its most usual fault grows out of our habits acquired with other materials. We are too much suckled on types of drawings done in thousands, adapted to the transient needs of advertising and illustrating.

The independent artist-lithographer should get all these other ideas out of his system: he should operate as purely in his own medium as do the etcher and the painter. Crayonstone happily enables him to lay aside haste, worry about editors, going to press, or the restrictions of any reproductive process. If he is brilliant, the stone will scintillate with him. If he is thoughtful, it will graciously encourage his most beautiful dream. If it is in him to make a real work of art, let him make it. Never will a better opportunity knock at his door than when holding a perfect crayon, he faces a perfect stone.

And yet, no one can do either himself or his medium justice the first time he tries, or the second. Interesting, even valuable things, if you will; but man may not be master anywhere without paying the price. And the

EDGE OF THE WOODS

Size: 14×10 inches.
Serial number of stone: 248.
Stone grained with carborundum, Grade F.
Crayon number: 300; made thus:

Stearine	820 grains
White wax	230 grains
Carnauba wax	230 grains
Babbitt's Concentrated Lye (saturated solution)	120 drops

Notes made at the time say: "The day was very warm but the crayon worked perfectly and the stone did not spread. Rolled up *on* the crayon."

Etch not given; probably about 1–48.

INDEX OF THE WORDS

Stars, 14, 20, 30, 60.
Stone, number of stones, 14.
Stone planed and polished, Grade F.
Strawberry number, pencil marks (Grade
Sir R. de
Wh[illegible] was
Cucumber-way
Hayward's Queen-ended Line (eastward solution)

Notice finally in the above way: "The day was very warm but the crayon work of perfectly and the snow did not shroud. Raked up on the gravel
Bed, on a very probably, three, 14, 48.

EDGE OF THE WOOD

price here is the loving labor necessary to bring about that intimate familiarity without which there is no master, only an experimenter.

Moreover, so intimate is the whole series of acts by which the design is translated from something drawn into something printed that really the artist should perform all of them himself. Ernest Jackson said to me, "Tell the fellows, in season and out of season, that they must do their own printing." In the mind of him who does this, creative imagination, including in its vision the exact steps necessary to turn his drawing into a print, presents to consciousness only ideas capable of being externalized in this way. Briefly, it enables him, as nothing else can, to do his imagining in terms of his finished work of art—his print.

Some people are forever proclaiming easy ways, shortcuts, and substitutes. As they tell it, royal roads turn off at every corner. They are wrong. There is no royal road to anywhere worth getting to, nor any substitute for a unique thing.

GRINDING A TEXTURE ON THE STONE

A stone with the proper grain is the first requisite for successful chalk drawing.

—Hullmandel

We have, however, more to think about, under the general head of "grinding," than merely texture. Often there is old work to be got off, and always we have to keep the top and bottom parallel. Calipers are used to test this in the shops, but I have easily got along without them. When I start to print, the press itself quickly tells me if the stone is unequal. If one end binds, I compensate by blocking up the other with paper under it—torn of unequal widths and laid to form a slope. Later, when I next grind the stone, I merely put a little extra work on the thick end.

For testing the truth of the plane surface of the stone, a rigid steel straightedge is used, though after some practice one gets along mostly without it. Having got the habit, I now grind a stone true unconsciously. At first I used to test by laying down a hair on the stone, setting the steel on it, and if at any point the hair was not held by the steel, the stone was hollow there and grinding continued. A bit of paper may replace the hair.

Originally sand was the thing used to grind with, but now other substances are also in use—ground flint, ground glass, emery powder and carborundum, among them.

The abrasive is put upon the stone with water and rubbed either with a second stone or with an iron shaped like a grindstone and called a "levi-

gator" or "jigger." Commercially, stones are commonly surfaced by machinery. A stone may be ground wet or dry. The latter is unusual. If adopted, the surface must be cleaned dry, with brushes and coarse cloths that remove every particle of grinding dust. Senefelder advises soap in the grinding water,—a very bad thing and liable to cause the stone to roll up smutty or grow soiled in the course of printing. A little sugar in the water helps keep the abrasive in an even layer. If a polish is wanted (though you cannot use crayon properly on a polished stone), it is got usually by pumice and Water-of-Ayr stone. This latter stone is known in the American market as "Scotch hones" when in flat slabs and as "snake slips" ("snake" is short for "snake stone") when in pencil-like prisms. It is a lovely, soft, fine-grained material found on the river Ayr, in Scotland.

Before stone grinding can be carried on in a civilized way, arrangements must be made to catch the slop. A tight box or tank of sufficient size with a couple of pieces of wood—say 2 by 4 inches—laid across the top to put the stone on, really furnishes the main essentials.

A common kitchen article, a sheet-iron roasting pan, has on occasions held a stone for grinding.

When your stand is established, put the stone on, wet it, and mix into water a spoonful or so of abrasive—more if you are using sand than if you are using something harsher. Set the levigator down upon it. Do it carefully, because the slightest bumping of the heavy iron may crack off minute unnoticed chips liable to plow frightful scratches into the stone. Experience will show you how to spin the levigator about, neither too fast nor too slow; how to add water; when to clear off the old sludge, thick and mucky from ground-up stone; and when to stop. Sand cuts down a stone more slowly than flint, and the latter not so fast as carborundum. Carborundum costs seven times as much as sand and cuts twenty-six times as fast. The coarser the abrasive, the harder the work and the faster the cutting. It is seldom worth while to cut with a sand coarser than will pass a 60-mesh sieve, or a carborundum coarser than number 100. When the old work has been thoroughly removed, put on finer powder—whatever you want, according to your intended drawing. When sand is used, its grains become round and worn down, in which state they yield a flat, poor surface. Toward the end, therefore, put on fresh sand and stop before it loses its tooth.

Delicate variations may be obtained by mixing different sorts of abrasives, by using grinders of different sizes, by substituting a second lithographic stone in place of the levigator (a very usual practice), by the amount

of water present, by the amount of muck allowed to accumulate, and even by the variety of the speeds used. When a second stone takes the place of the levigator, a tendency toward convexity must be guarded against in the lower stone. By means of small grinders different parts of the same surface may be given different textures, each suited to that part of the design which it is to receive.

When the grinding is finished, flush the surface very thoroughly with great quantities of clean water. Then set the stone on edge in a clean place to drain and dry. Keep your hands off the surface; also, protect it from dust.

In grinding off old work from a stone, very rich drawings that have carried a deal of ink will need more prolonged grinding than delicate ones. Also, work which has remained weeks or months upon the stone will require to be ground more severely than recent work. In using carborundum, I generally get the necessary results by one grinding of No. 150, followed, in order, with one grinding of each of the successively finer grades, 180, 220, F, FF, stopping at that grade which suits my intended drawing.

Do not let the appearance of old work, after some grinding, unduly intimidate you. It will, or may, show as a pronounced light pattern. If insufficiently ground, this pattern may, as you print, begin to take the ink. Yet it is not always necessary to grind it totally out of existence. I have ground and printed an edition from a stone showing such a pattern of old work, without any harm from it at all.

Avoid grinding in a stiff muck of pulverized stone. Clean off and start anew before you reach this stiff stage. Don't use too much water just at first: it washes the abrasive off the stone. Don't use too little water at any time. As the water-film between stones grows thin, there comes a point where a suction action sets in, the stones being squeezed together by atmospheric pressure. Normal textures do not result if such conditions prevail.

I have forgotten to mention the rounding and polishing of the stone's edges. This is done with powerful rasps, followed by finer ones, finished with a polish got by Water-of-Ayr stone. The purpose of these rounded edges is to prevent chipping, keep paper from creasing, and, much more than all others combined, to keep the ink from sticking to them. Angular or rough edges insist upon getting inky.

Do not allow anyone to make you believe these technical things are impracticable—they are not. As to time, I can surface an ordinary stone and have it ready to draw on in 15 minutes, not longer than is required to stretch a sheet of water-color paper.

III. THE CRAYON

LITHOGRAPHIC CRAYON IN GENERAL

THERE exist numbers of marking substances, crayons; but from all of them lithographic crayon has one distinguishing characteristic, it is adhesive. Ingredients in it (waxes more particularly) give it this quality. As there are several different waxes available, by combining them in different proportions we can make crayon of almost any degree of adhesiveness. Soap also is a common, but not a necessary, ingredient. Though it is an adhesive substance, it is vastly less so than most waxes. Make a mark with beeswax and one with soap and you see—one sticks, the other slides.

Aside from differences in adhesiveness, crayons may differ in hardness. It is possible to keep these two qualities distinct. You can make crayons vary in hardness without varying in stickiness, and you can make them vary in stickiness without varying in hardness.

Every crayon, having its particular hardness and its particular degree of adhesion, necessarily compels the artist to use his muscles in a way determined by these peculiarities. With a hard crayon I must hold my hand more stiffly than with a soft one. Holding my hand stiffly, I can draw only certain sorts of lines. My drawing must be brought into existence out of just these lines—no others. Other crayons give different lines, and different sorts of drawings grow out of them. Hard crayons tend to produce narrower lines than softer ones; also, lines which vary in width less readily in response to pressure than softer ones do. I have crayons that produce marks almost as narrow and even as silverpoint, and others so soft that their mark is almost like that of a painter's brush.

Not only does every different crayon demand a different muscular tension, but there are certain differences that affect the eyes and through them the constructive imagination and the very way you see nature herself. You do not, when you change one crayon for another, merely go on expressing the same things in a different manner. You express different things. You do

this because every crayon keeps telling your physical senses—your hand and your eye—that it can do this and cannot do that—operating in this way an unescapable suggestion on the mind itself. And the wiser you are the more freely, fully, and delicately you follow this suggestion; the more foolish you are the more you do not feel it or see it or follow it, but go on fighting with it.

To work with different crayons in this way is obviously highly educative. With each change you get a new pair of eyes and a different cast of mind. In a word, you get, to an extent greater or less, a different world.

It remains for the future to develop these possibilities of lithography; the past can hardly be said to have so much as touched it. It has not been known to exist. Two or three standardized commercial crayons were all the past had or thought of.

Korn's crayon is marketed in three forms: the traditional square or round sticks, square slabs, and pencils like a lead pencil. The sticks are intended to be put into a portcrayon, like the standard dry crayon whose form they follow; sharpened, and thus drawn with. Some artists, however, hold the stick directly with the fingers, though the heat softens and injures the crayon. Painters or others habituated perhaps to pastel or charcoal, if they like something broader, can use Korn's square cakes.

Mr. Korn in person told me his crayon is made of the four regular ingredients. Senefelder's book gives a number of formulas for crayon which result in an article resembling Lemercier's. The old Paris firm of Lemercier & Co. (now, I believe, Van Huymbeck) puts out a widely used crayon based on a very elaborate formula.

The market affords types of crayon of extra softness, intended not to be drawn with, but to be rubbed on leather or other suitable surface, for stumping.

Most of the old crayon formulas rely on soap, tallow, shellac, wax, and lampblack. The black is merely for visibility and is chemically inert.

All the resins, with which we must group shellac, contain fatty acids. Waxes, excluding those of mineral origin, also contain organic acids capable, like those of fats and resins, of reacting with the alkaline limestone.

Speaking very loosely and merely for momentary clarity, we may lump the harder of these acids as stearine and the softer as olein. Either kind will attack limestone. By blending them, harder or softer crayons, equally effective chemically, can be made.

I have myself evolved original formulas for crayons; have made, drawn

with, and etched them, to the number of, at present, four hundred and forty-six. These have involved the use of a large variety of substances.

Two separate demands are made upon all crayons—one by the artist, the other by the printer. A variety of substances are needed to give the physical properties desired by the artist; tallow or soap is enough for the printer.

Any artist may make crayon. Whether he uses permanently his own product or not, to make and understand it is of educational value to him.

The established way to get harder crayon, beginning with Senefelder, is to burn the melted mass till it yields a cooled substance of the consistency desired. Experiments taught me that, although burning will harden a mixture somewhat, it will not harden it more than a moderate amount. Another old way of hardening is by the introduction of saltpeter. Dissolved in hot water, successive drops of the solution are stirred into the hot crayon. I tested, and I understand, these methods. But in the end, I came to depend hardly at all on burning, but on using hard ingredients for hard crayons and soft ones for soft crayons.

In the great period of crayonstone lithography the grade generally used was the one next softer than copal, equivalent to Korn's No. 4. This refers to fine portraits and the like. If the weather was sufficiently cold, the next grade softer was substituted.

THE ARTISTIC QUALITIES OF CRAYONS

The excellence of an instrument is in its ease, exactness, and completeness. The violinist draws bow over string; the artist draws crayon over stone. The tone of one, the line of the other, is a human expression—one heard, the other seen. The ease, exactness, and completeness of this expression measures in each case the excellence of the instrument. And both the instruments mentioned are, each in its world, of extreme and equal excellence.

The profound influence which his materials have upon the ideas and habits of the draftsman, their determination for him of this or that quality of nature or this or that attitude in himself, is so well known as to be almost self-evident. But while this is the case with other methods, the materials out of which lithography is evolved have been so hidden from the present generation of artists that it is hardly grasped at all. Lithographic crayon has been simply accepted as "greasy chalk," and the matter dropped.

Just what its qualities really are, and why, and how inevitably—are questions that have hardly existed, still less been answered.

The chemistry of the crayon is what makes it print well but not what makes it draw well. As has been said, the crayon has a double service; one to the printer, the other to the draftsman. From the time of Senefelder, whom we must class here as a printer, downward to our own, lithographic crayon has been controlled by the demands made by the printing. Consequently, printers have been well served; artists not so well. Art has simply had to do the best she could.

After I, an artist, had mastered the printing, I began to realize how much better the drawing material might be. Senefelder's hundreds of experiments left him with a small group of printer-made formulas, types of all their successors, which gave usable crayons which would etch and print. I began where he left off, following his printer's hundreds of experiments for a printing crayon with my artist's hundreds of experiments for a drawing crayon. My crayons are a marked improvement over all others. They include a crayon much harder than has been available, and others as soft as human hands can use. Also, in all grades I accomplished a surprising reduction of what has always been the great shortcoming of lithographic crayon —its stickiness. I have tried to get manufacturers to make it, but as yet not successfully. Also, I have a range of crayons more nearly resembling the working feel of non-lithographic crayon, as well as yet another range having a feel of extreme silkiness, so great, in fact, as almost to be comparable to the free gliding quality of the lead pencil.

Since in all crayon drawing (using the word in its widest sense) the artist finds it occasionally expedient to use various rubbings with his fingers, stumps, rags, and the like, I undertook numerous wide-varying experiments to increase this power on stone. Some of the results have been so extraordinary as almost to constitute a new art. (See my section on "The New Process," p. 66.) I found chemistry so much more subtle than optics that I had to learn to get and to print things which were invisible in the original drawing. The new effects thus brought into the art, corresponding aesthetically to the rubbings of the charcoalist and the stumpings of the pencil draftsman, are not got by similar rubbings but by chemically planning the crayon, the wetting, and the roll-up, so that the artist, in performing these operations, has the power to develop and control them. Stumpings and rubbings of lithographic chalk have always been possible and have been used, but

never have they yielded results like those got chemically, by the artist, as he develops and manipulates his drawing into a printing surface.

But to return to the crayons themselves; I made a range of crayons which vary, in their attack upon the stone, from a roll-up of excessive faintness to one of extreme fierceness. Another series is characterized by closely studied degrees of solubility, so that in wetting for the roll-up, one can, according as he uses this or that, forecast how much his crayon will enrich the roll-up and print. (See "The New Process," p. 66.)

With these experiments went a parallel series to define the effects of various baths on various crayons; thicker or thinner gum arabic; gum arabic made acid, made neutral, made alkaline; as also of gums other than arabic —dextrine, starch, caseine, molasses, albumen, honey, sugar, etc.—these in sundry mixtures and dilutions.

Having long worked with and enjoyed the crayons of Lemercier, Korn, and Currier, I one day handed my son a casual chunk of Japan wax and another of soap with the request that he melt them together for me. The results at once stimulated me into weighing out equal parts of the same ingredients, plus black, and thus building my first complete home-made crayon. It worked well. I drew with it my lithograph entitled "Mt. Woodworth."

From this beginning, one after another I took up yellow beeswax, white beeswax, Chinese wax, ivory soap, yellow laundry soap, castile soap, olive oil, palm oil, beef tallow, mutton tallow, lard, cottolene, mineral oil, lanolin, paraffin, vaseline, stearic acid, oleic acid, saltpeter, bitumen, gum mastic, lye, and maybe other things now forgotten. With a saturated solution of Babbitt's Concentrated Lye from the grocery store, I sometimes more or less saponified some of these substances. I read volumes on soap-making and many monographs on these natural products, their origin and preparation. Gradually from much fascinating but superfluous information I culled the facts necessary to the making of the crayons I wanted to produce.

Almost as a by-product, I turned out one day a very good lithographic drawing-ink. Lye, oleic acid, lamp black, and water were its ingredients. With it I made on stone several pen drawings, as well as others with a brush. I preferred it to any I had used, as also did George Bellows, who never used anything else after I had furnished him with this.

Crayons that attack the stone lightly, thus affecting the roll-up in this

THE OLD HOUSE

(Drawn with the Softest Crayon)

Size: 10¾×7½ inches.
Serial number of stone: 228.
A technical experiment; no notes kept. Edition, about 20.

direction, are got by dilutions with paraffin, or paraffin and carnauba, for the harder ones, and vaseline or mineral oil for the softer ones, none of these substances, except carnauba, having any chemical power of reacting with the stone at all. All of them, carnauba included, resist the etch superbly.

Crayons of an opposite character, attacking the stone strongly and yielding an enriched roll-up, are produced by the use of greater proportions of, chiefly, palm-oil.

Crayons particularly sticky are generally the result of using sticky ingredients—mastic, bitumen, and sticky waxes.

Crayons that are insoluble result from the use of stearic acid; this acid is totally insoluble yet affects the stone perfectly. It is hardened with carnauba, softened with mineral oil, and may be slightly modified by adding lye to the hot crayon in process of making. My first batches of stearine crayon contained annoying white specks of harder stearine, a trouble I corrected next time by first straining the melted stearine through a mass of cotton batting. Not only is this crayon insoluble, but its working quality is excellent, being far less sticky than any commercial crayon. All of George Bellows' later work was done with such crayon furnished him by me. Chauncey F. Ryder, Albert Sterner, George A. Picken, John Sloan—in fact everyone who has used it has preferred it.

With this crayon one may draw, even under water, not only without trouble but with even a certain added facility. Work so done rolls with a peculiar clarity. Only mermaids would care to draw habitually under water, perhaps; but this waterproofness is, nevertheless, an advantage. It keeps the hands clean, and by consequence the stone, since the sweat does not soften the crayon. Neither, for that matter, does the heat soften it very much: I have drawn with it on stone in the open fields under a hot summer sun without noticeable change.

In the summer of 1927, Alfred Hutty, the etcher, studied lithography with me. He was planning to make a drawing of a certain old apple tree over in my orchard, but it rained. I said, if the artist can stand the rain, the art can. I gave him one of my waterproof crayons and he drew an excellent study on the stone with the rain running down it literally in rivers. The roll-up and print showed not a trace of anything unusual. I want this feat to go on record—as a turning-point in technical history.

Moreover, one can add work in the water, after the roll-up has begun—

rolling it at once, adding more, and again rolling—and so build up a work then and there on the wet stone, a thing never before dreamed of. It is in this crayon that the element of adhesiveness is reduced to a minimum, the amazing thing being that a crayon so light and almost crumbly should yet be able fully and inevitably to attack the stone. Loose particles of it do not, as with common crayon, stick to the stone and require to be picked off individually with needle or knife; they are dusted off, and leave no mark.

A variation of this type results from melting the stearine and adding, drop by drop, saturated solution of lye in various proportions. This addition of alkali affects the working character of the product, yet does not make it soluble.

All these crayons show a surprising power of withstanding the etch, many of them distinctly surpassing, in this respect, the regular crayons on the market.

When I had got as far as this, I started a final attack on the problem of getting a crayon which marked with the absolute maximum of smoothness and the absolute minimum of either stick or abrasive drag. These stearine crayons, or stearine and carnauba crayons I have been speaking of, have almost no stick; yet, compared with such a substance as graphite, they do have a slight crumbly drag.

Soap being notoriously smooth, I bought large bars of genuine castile soap, selecting the hardest. This, of course, itself makes a mark that rolls up perfectly, and even more richly than pure stearine. Needless to say, this soap mark *is* soluble—very much so.

The hardest wax is carnauba: it is about as hard as mastic. But whereas mastic and all resinous bodies—copal, shellac, bitumen, etc.—cause stickiness in the crayon, carnauba will yield quite as hard crayons without doing so. Carnauba has an excellent power of resisting the etch. Some of the pieces sold me contained grit. I melted them; the grit settled, and from the bottom of the cooled cake it was easily scraped off.

Mixtures of carnauba wax with castile soap give crayons that work with amazing smoothness. Naturally, the degree of solubility is in relation to the proportion of soap present. The hardness is relative to the carnauba. The hardest are therefore least soluble; the softest, most soluble. Proportions in my formulas have ranged from as high as 80 per cent carnauba to as low as 33 per cent. The very hard ones may, or may not, contain a minute

addition of palm oil, which itself may or may not be saponified. The hardest of these crayons are considerably harder than Korn's copal; the softest, ranging perhaps near Korn's No. 3 and No. 4. To get softer ones, I found it less expedient to add more soap than to add mineral oil. This carries the scale perfectly down to about No. 1.

To these carnauba-castile crayons I added the finest calcined lampblack, in quantity about 10 per cent by weight of these other matters. The softer the crayon, the less pigment is needed.

Interested by the discovery that the pigment slightly reduces the silky working quality of the crayon, I made numbers of most fascinating crayons in which the pigment was reduced to some 2–4 per cent of the total. The drawings of course were not black but a lovely pale gray. But the roll-up and print were gloriously full.

Good crayon, withstanding very fierce etching, can be based on paraffin with a minor proportion of palm oil.

Crayons for drawing on paper to be transferred for planographic printing need some stickiness. Ordinary commercial crayon works well in this respect. I made some that transferred as well and were much pleasanter to draw with, using Japan wax, or beeswax, or Chinese wax.

Japan wax is, chemically, more of a "vegetable tallow"; and I readily turn it into soap with lye. For my purposes, the difference between the soap and the wax is that the soap works more smoothly. The wax itself, however, makes a perfectly printable mark on the stone.

MANIPULATION IN CRAYON-MAKING

By way of showing how anyone can make crayons, I will sketch my own simple operations. My scales consist of a flat stick about 18 inches long, notched below and balanced. The weights, of wax, range from 3 grains to 300 grains. A druggist weighed them out for me. The weights for 1 and 2 grains are pieces of paper. This outfit works perfectly, costs nothing, and is never out of order.

Numbers of my most valuable experiments were melted together in a tablespoon, releasing themselves in a cake when cool. I cut the cake lengthwise and have made many a happy drawing with these pieces. The ingredients of every lot are weighed and the formula recorded. The total weight of these small lots is about 120 grains. To make what my notes refer to as a

real "batch," I multiply this by from 10 to 15, according as the article is harder or softer. The harder the crayon, the thinner may be the cake.

A batch is from 1,200 to 1,800 grains of permanent matter. By saying "permanent matter," I exclude water added with lye. (No account is taken of the weight of this added alkali.) I melt them in a clean sheet-iron frying-pan having a bottom diameter of about 5 inches.

The procedure is this: I first think out carefully what the forthcoming crayon is to be. Then I write the formula and set it before me, thus:

Palm-oil	5 grains
Carnauba wax	50 grains
Lye	30 drops (sat. sol.)
Stearic acid	45 grains
Black	10 grains

and proceed to weigh out the items, checking each on the list as I do so. Then into the melting-pan go the carnauba and the palm-oil, which are set over the fire. I have made crayons with equal success over wood fires in a country cook stove, over an oil stove, and over a gas stove. If the fire is hot, I shake the melting contents about or stir it with my favorite instrument, a common table fork. When it is smoking hot—very hot indeed, mind—if lye is to be added I put it in, drop by drop, stirring constantly. Sometimes I follow (and often I do not) the old rule of bringing the temperature to the point of combustion, light it with a match, and allow it to flame a longer or shorter time. Sometimes this burning is used to help get rid of froth. Having extinguished the blaze, by blowing it out or by covering the pan, I immediately dump in the lampblack. Here it seems best to go slow, allowing, before any stirring, a certain creeping absorption with which the very hot wax slowly takes in the fluffy lampblack. The idea is to avoid getting the large quantity of air which the lampblack carries mixed with the crayon in the form of a mass of bothersome froth.

When the black has all become wetted by the wax, I stir it thoroughly for a minute or so—not long—then, taking it from the fire, I continue to stir until cooling causes the first symptoms of viscosity to appear. Holding the pan level, I give its edge a series of sharp raps, to encourage the emergence of any bubbles, and set it on a level surface to cool.

At this point I will refer back to a mention of lye. Let us assume that we have a formula using not lye but a ready made soap, say castile. I buy huge raw cakes of this nearly as big as your arm, genuine Spanish and the hardest I can pick out. From one of these I scrape with a knife diaphanous

shavings to the weight required. By rubbing these in my hands a little, I reduce them to a mass of small flakes. When the wax is at its fullest heat, almost aflame, a pinch of these flakes is stirred in. There results a little froth and then clarity. This is repeated till all the soap has been thus incorporated. The heat must be kept well up or the mass becomes gummy instead of truly liquid. Following this the lampblack is worked in as described. Those crayons containing a very high proportion of soap (as many of my carnauba-castile ones do) are a trifle more troublesome to compound, though there is no real difficulty.

I have never seen any crayon made, except my own, nor enjoyed the privilege of visiting the inside of a crayon factory; but I find the literature of the subject speaks of making crayon sticks by "molds" and "pressure." Doubtless this is a perfectly good factory practice, but I can assure the reader that in home production no lack is felt in its absence. The sticks I make are solid and homogeneous without mechanical compression.

As to their cost in time: I can weigh out, melt up, and set to cool an ordinary batch in about 20 minutes. As to the cost in money: the materials in one batch can hardly cost above 10 cents, and the result is about 3 ounces of crayon more perfect than any that can be bought outside at any price.

When my batch is cool, it leaves the pan as a thin round cake, dull on top, shining on the bottom. This may be broken or cut in any way one chooses. I most usually saw mine into sticks with a fine-toothed hand saw. These sticks I commonly draw with just as they are, without any handle; but they can readily be put into a crayon-holder. Often I use two lengths of the crayon, the longer one to hold as a pen is held in writing, the smaller one short enough to work under the palm of the hand.

Lately I took a piece of sheet lead and hammered it into a little rectangular tray. I now pour my crayon mixture into this, instead of cooling it in the frying-pan. When it is cold, the cake readily releases itself and can be cut into about ten sticks of equal length, for which operation I no longer use a saw but a wood-engraver's burin.

THE LITHOGRAPHIC TOUCH

All the old treatises, written when many fine lithographs were being made, either lay down specifically or take for granted that the hand that applies the crayon is to be used in a way peculiar to lithography, a way based on the idea that it is necessary to *stick* the crayon firmly to the stone. All

crayonstone draftsmen were taught this and did their best to live up to it. An "old timer" has talked to me about it, explaining that whereas any good draftsman could make a lovely drawing on the stone, unless he had done it in just a certain way it would not print well.

Hullmandel has things to say to the same effect. The hand, he tells us, is not to be moved rapidly, lest enough heat be developed to soften the point of the crayon and injure the quality of the work. The stroke is to be clean, firm, and with a muscular and mental feeling recalling the slow spreading of thick paint.

Vincent Brooks (of Vincent Brooks, Day & Son, London) also states that "a patiently executed specimen will stand more etching than a hastily drawn one," the significance of this being that the more etching a drawing will endure without harm, the more prints can be got from it.

It is well, however, in the light of the foregoing statements, to remember that the persons who made them were not thinking of the kind of lithography this book contemplates—an artist's private adventure—a score or a hundred of wonderful proofs, and no more. They had in mind work done by professional draftsmen, for publishers who expected probably thousands of prints to be taken.[1]

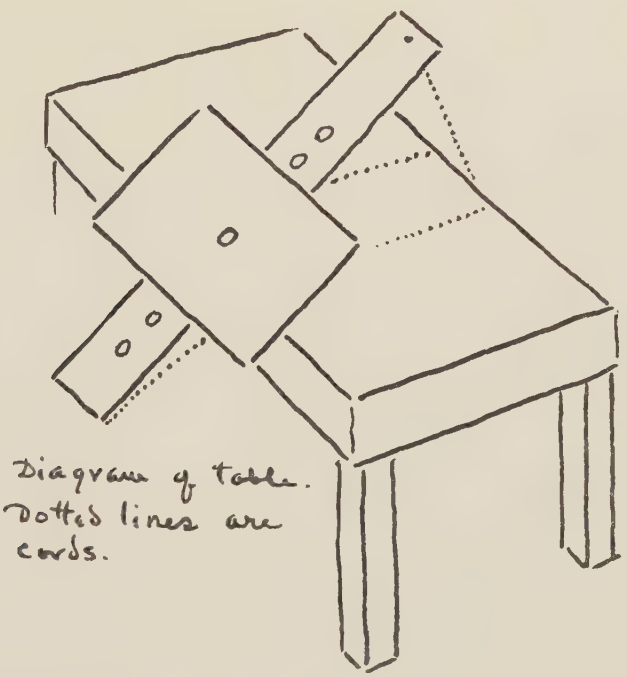
Moreover, with all due respect to the superb things sometimes accomplished by the early men—things no one is better qualified to appreciate than the expert printer of today—I have been forced to the belief that those craftsmen could not themselves really explain completely all parts of the operations they utilized with so much skill. They believed that the crayonstone drawing is essentially a physical affair, an affair in which "soaking-in," etc., is essential. My own experience indicates that the function of the drawing is essentially one of colloidal chemistry, in which the physical element may be largely ignored. In any number of cases I have made drawings ignoring all the requirements demanded by the physical theory and, fulfilling all the requirements of the chemical theory, have pulled brilliant impressions.

I therefore lay it down that if you understand the chemical facts you need pay but little attention to the "lithographic touch." You simply draw what you want as you want it, and it can be made to print, perfectly and in reasonable numbers.

[1] "The crayon process, which enables every artist or printer to make several thousand impressions of his original drawings."—SENEFELDER.

IV. DRAWING ON THE STONE

A SPECIAL stand to hold the stone may be bought, or one may be invented and built. My own invention is good, and anyone can make it. Inch holes are bored in a row along the center of a strong board 4 feet long and 10 inches wide. Low cleats are strongly tacked around the face of a thick drawing-board. The bottom of the stone fits inside these cleats.



The center of the back of the drawing-board carries a round peg an inch in diameter and not longer than the thickness of the 4-foot board. This peg fits loosely into one of the holes in the long board. This enables the drawing-board, with its stone, to be revolved on a center (the peg) in its own plane. This center is moved at will up or down the board by using the different holes. Along the lower edge of the lower end of the long board is a groove deep enough to carry strong sash cord. The board rests at right angles to the edge of the table. The weight of the stone is so placed as to

cause the long end of the long board to tip up. A loop of sash cord fastened to the table receives the lower end of the board, which may thus tip up even to the vertical without slipping to the floor. The long board is maintained at an angle by a movable cord attached to its upper end and to the far edge of the table.

A strong easel will hold a stone; or it may be set upright parallel to a table's edge, another stone at right angles buttressing it from behind. It may be held on the lap, protected by a pillow or two, the upper edge resting against a table.

Owing to its being alkaline (lime), the stone has a keen affinity for the fatty acids of grease, with which it forms an insoluble compound. Even the faint oiliness natural to the human skin may, if the hand is rested a moment, produce a spot that will take ink and print. Though it may not show when printing begins, it may gradually do so as printing goes on. Touch the stone, therefore, when necessary to touch it at all, lightly, swiftly and with hands not perspiring.

Lithographers sometimes use the border of the stone as a place to test their crayon, the marks being eaten off later with acid or ground off with pumice. Another way of dealing with the stone's border, which I often prefer, is to paint it over with gum arabic. This insures its cleanness after the gum is washed off.

To keep your hand from contact with the stone surface, you may evolve whatever artifice suits your idiosyncrasy. A good and very old way is to use a wooden bridge with cleats under its ends. Paper is used, but it is treacherous: it will keep the grease of the hand off the stone but will not stop the penetration of vapor from the hand, which, condensing upon the cool stone, may cause a spot of mischievous dampness. The mischief of the dampness may be a slight softening of the sizing of the paper. This allows a trace of it to stick to the stone, where, by preventing a perfect crayon contact, it causes a light spot in the print. Or, it may cause a dark spot in the print by slightly dissolving the crayon of work already done. I have recently adopted, with satisfaction, a paper made for damp-proofing packages, enclosing a layer of asphalt. Before I discovered this paper, my preferred plan was to fold around a slab of pasteboard, or the like, a piece of thin oilcloth or "rubberized" fabric, outside of which I pinned or sewed a clean handkerchief.

Naturally, when the stone is upright or on an easel, the rest-stick is

available. Some artists prefer no support for the hand at all, yet even they will at moments steady their stroke by just touching the last finger. A handkerchief wrapped around fingers thus momentarily on the stone makes this safe. I sometimes use a cotton glove from which the thumb and first two fingers have been cut. The simplest scheme of all is just to catch a clean handkerchief with the little finger, holding it as a pad under the hand.

When chips and grains of crayon appear on the stone, beware of brushing them with the hand—still more of blowing them away. Dust them gently with a soft brush or a cloth. The reason for not blowing on the stone is that specks of spittle thereon leave a film that prints a white spot. A workman in London read me a warning in the fate of an industrious professional who ruined a "Coronation of the Queen" (several months' work) by an ill-directed sneeze.

Some of the manuals written by the early masters even denied a man the liberty to breathe on the stone, and prescribed a sort of nose mask. A cold stone will, it is true, condense breath on itself, but personally I have not been bothered by this; and I never used a mask.

The various precautions here suggested for the protection of the stone are sufficient to insure the flawless production of the most refined and exacting work. Naturally, they are equally effective on other types of work. However, where one is drawing in another mood, he may not object to some degree of slackness in the technical harness or to the effects of it in his print.

Work upon the stone may of course be commenced directly with the crayon, but often it is advantageous first to feel out the design with some material that does not give a printing mark. Charcoal is good for this, most of it being dusted off before working with crayon. The merest trace of hard pencil will sometimes serve, but if any appreciable body of graphite is present on the stone, it will prevent the crayon from coming in contact, thus resulting in light lines in the print. Type metal, as well as brass, is used to make a mark that will not print. A lead-pencil mark made on a wet stone is less likely to print than one drawn on a dry surface.

Much nonsense has been talked relative to the difficulties of carrying stones about to work on directly from nature. A soldier boy can carry all day as much weight as an ordinary lithographic stone, and any artist with a little enterprise can get a stone anywhere he wants it. Wrapped in a cloth or blanket, a grained stone ready to work on may be transported in an automobile, a buckboard, a street car, a motorcycle, a delivery cart, a child's ex-

press wagon, a knapsack, a bicycle luggage-carrier, a pack mule, a wheelbarrow, an airplane, or a boat. Either spontaneous sketches or careful drawings may be done from nature anywhere. And for those who will believe this and go forth and act upon it, new laurels are waiting. Seymour Haden etched masterpieces in the open fields, working in a tray of acid, a method incomparably less facile than drawing on a stone.

A faint suggestion, in crayon itself, might be transferred, and afterward carried to completion on the stone. If more than a mere suggestion is attempted in the transfer, a conflict may be set up between the texture of the transfer and that of the stone work.

The print comes in reverse from the stone, and a right-handed figure in the drawing will appear to be performing with his left in the print. Local scenery, when its local quality is important, must be reversed. Drawings from nature, as observed in a mirror, will give prints that are like nature. When you want to use an existing design just as it is, without reversing, lay it flat on a table, set a mirror on the table just beyond it, bring the top of the mirror forward until you see your design in it as upon a vertical surface, fasten the mirror in that position and go ahead and draw from the image it shows you.

Work needing correction can be ground out, locally, by a small grinder and dry abrasive; or it may be washed out with benzine—this to be taken up with a blotter. One experienced worker I know used India rubber, but I do not recommend it. Personally, when my own work goes wrong, I rarely do much tinkering, but grind off the whole and make a clean start. I prefer the morgue to the hospital.

To get a tracing on the stone, rub the back of the paper with pulverized sanguine, or red lead, or burnt sienna, and lay it in its place. Touch its two upper corners with a trifle of gum arabic and stick them down, taking care that the gum is not in the territory you propose to draw on. Trace over the lines with any convenient point. Remove the paper, whisk off the superfluous red dust, and proceed with the crayon. Never use waxy or oily tracing-paper.

A tone may be part of a modeling system, as on a nude figure, or it may be a veil of atmosphere in front of objects, or a veil of shadow over them. In the first case, it stands for a surface and does not require to be broken into; in the second, objects and their markings do break into this veil of tone; and in this latter case, the way one gets the best results is not by fol-

STORM

Size: 11 1/2 × 2 3/4 inches.
Serial number of stone: 450
No notes made.

STORM

Size: $11\frac{1}{16} \times 12\frac{13}{16}$ inches.
Serial number of stone: 450.
No notes made.

lowing one's nose and drawing the objects first and then putting the veil over them, but by reversing the process, drawing the tone first and laying his lines and touches into it.

Any touch laid upon other work already drawn will both look sharper and print better if laid in the direction opposite to that of the work it is put upon.

For accents, cut the crayon chiselwise; for sharp accents, *push* the crayon against the stone; for black accents, touch the tip of the crayon to the tongue. Broad gray touches should be made not by sliding the point on one of its flat faces but by pushing it toward one of its sharp edges. Lovely work may be done by cutting the crayon like a lancet—broad, and sharp along one edge. The edge is pressed on the stone and moved as a razor is moved in shaving. The marks will be broad, clean, and airy. Lines of the same width produced by pressing a flat facet of the crayon into full contact with the stone will have a totally different and inferior character. They will be less perfectly defined and more coarse and dirty.

Crayon may be used sidewise, producing a flat ribbon of tone with a single movement. For this an edge, not a face, should be presented to the stone. Unless used with care and skill, the method easily becomes degenerate, yielding clogged and ragged work. The peculiar capacity of lithographic crayon to give when mismanaged the most extraordinary messes full of blots and specks is due to its being a slightly sticky substance. It is not quite a dry crayon in the sense that all other artists' crayons are.

Bits of dirt get bedded in the facets of the crayon: cut them off with a knife or rub the crayon on coarse woolen. Foul crayons and dusty stones make "rotten" lines and pock-marked tones in the proofs.

If a tone has become too deep, it may, if gone about circumspectly, be lightened by working it with a strong sharp needle. Or it may be scraped with the point of the scraper or the knife. All such work must be done rather vigorously and actually *in* the stone. If you simply mess around on the surface, the result will be particles of crayon poked about into new and unintended attachments, so that the place you are trying to lighten will merely be sullied and may even print darker than it would had you let it alone.

Pulling the scraper or knife-edge sideways causes it to jump, and each time it lands it cuts a notch in the stone. Very ugly work has been done by this method; but if used within reason, ugliness is not a necessary result.

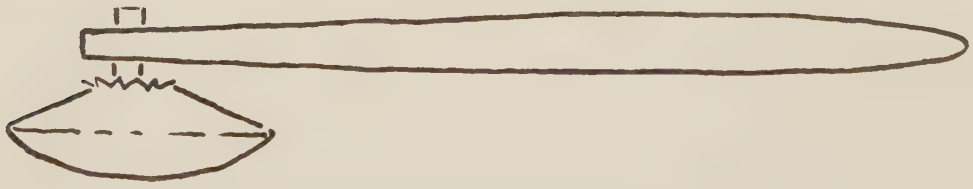
Black specks in a tint may be removed with a sharp needle; large clots, with a knife. The early masters thoroughly believed in such removals and practiced them extensively. A scrape of the knife point, not a jump or a cut, can be made to give a line that will print gray. Calame was the greatest user of the device of the gray scrape—the rock surfaces, foliage, and grass in many of his prints being largely created by it. He was also extremely skilful in scraping white high lights indicating the forms of the water surface in the turbulent streams he was so fond of.

Lights that are cut out to print white must be literally dug out of the stone. Only this will certainly keep the place from darkening up as the printing proceeds.

As an art critic, I advise against the excessive use of these devices. And as a printer, I advise that, when they are used, the best time to do the work is after the roll-up, before the final etch, in the wet gum. This assures the cleanest work, since, in the presence of the wet gum, no new attachments can be formed.

TINTING THE STONE

Among the ancient ways for putting a printing tone over a stone, into which the draftsman can draw and out of which he can scratch high lights, is one based on the use of a light, kid-covered dabber with an 18-inch handle at right angles to the motion of the dabber. It was used with a very light load, and by a great number of gentle taps an even tone was created.



I have made beautiful tints by similarly charging the flat of my forearm with rubbing crayon and sweeping the stone with it. All such rubbed tints print darker than they look in the drawing.

My more usual method of making a rubbed tint is to tie up a pound or two of sand loosely in a piece of chamois skin. I apply rubbing crayon to a paper, drag the chamois skin about on this, then apply it to the stone. (See my lithograph, "Wintergreens," etc.)

Another method is to sift pulverized asphaltum on the stone and then

apply just heat enough to make it take hold. This will print; and through it, by careful scraping, white clouds, aerial gradations of sky, etc., can be got. Harmonious crayon-like lights can be drawn into such a tint with a piece of cuttlebone. Isabey used this cuttlebone expedient with beautiful effect.

Another way the fathers of the art had of getting a comprehensive tone to begin their work upon, was to hire a professional "tinter" to go over the entire field. He used short, light, horizontal touches executed with the tip of a very fine point held by the extreme end of a portcrayon and with only the crayon's weight upon the stone. Each stroke began with invisible delicacy and finished in the same way. A series was made, one lying close below the other, like clouds in a herringbone sky. A second series was executed, so close to the first that the soft ends of the touches overlapped. The stone was now tinted, but the tint showed vertical bands. So the operation just described was repeated, this time with the center of each horizontal stroke falling just at the lapped ends of the first series. Ultimately a true tint was acquired, though it was not a finished article until its creator had gone faithfully over it with a very sharp needle, picking out all crayon specks large enough to be caught by the human eye.

Still another way to get a general tone is to whittle a small pile of crayon chips and sweep this about the surface with a camel's-hair brush.

Some use a stump, just as in ordinary crayon drawing.

When you are very clear as to your future intentions, you can put in high lights by covering them with touches of gum before you draw. When the gum touches are dry, crayon will not affect them, and they will be represented in the print by pure white.

Hullmandel's dabbing method, above referred to, was to be used upon a bare stone, in advance of the drawing to be made upon it. Different depths of tint were confined to their proper boundaries by stoppings out of sufficiently dark areas with a stop-out gum. This gum carried a small addition of "candied sugar" to prevent cracking, and enough gall to prevent repulsion from greasy crayon marks. But as this method required gum to be put on the stone in advance of the drawing, there was always danger of trouble from non-adhesion of crayon due to the traces of gum in the stone.

I have found it practicable to execute certain kinds of work by tones carried right over the completed drawing instead of being put down in advance. To do this, proceed as follows: Draw outlines and character mark-

ings. Rub a tone over the entire design as dark as your highest light. Paint stopping-out gum with a little sugar and ox gall in it, over the areas that are dark enough. When this is dry, rub on more tint and again stop out, proceeding thus until you finish. As a tint thus rubbed carries in its appearance hardly anything by which to judge how dark it will print, the depth must be more or less judged by the amount of time given to the rubbing, on a basis of former experience. Naturally, work thus executed is free from the trouble Hullmandel warns us against.

LITHOTINT, PEN, ETC.

There is a way of making a tone on a space by a wash. The wash may be crayon dissolved in turpentine, water, or other solvent; or it may be a liquid ink manufactured for the purpose. Picturesque blots or pools may thus be made, but the defect of the method is its unreliability as to values. Its appearance when laid is different from its appearance when dry, and it can rarely be depended on to roll up and print as it looks either wet or dry. A successful lithotint is in Duchatel's book *Traité de lithographie artistique.* Others are by Harding. But Harding seems to have had the advantage of a peculiar invention of Hullmandel's (patented, I believe) which partly accounts for some uniquely successful prints of his, made by him entirely in wash and printed by Hullmandel. Whistler tried it a few times, unsuccessfully, and gave it up.[1]

[1] "It is generally supposed that Way was the actual printer of Whistler's lithographs. Way was the name of the firm but the man who pulled those proofs was my old friend, that delicate and sensitive artist of the lithographic printing roller—H. P. Bray." From an article on "Lithography," by F. Ernest Jackson, in the *Print Collector's Quarterly XI* (April, 1924), 214.

The Kennedy catalogue of Whistler's lithographs indicates some ten as "lithotints." Three of these, Nos. 8, 9, and 131, are not correctly described, the bulk of the work in each being crayon. Of those remaining, no less than four, "Early Morning," "Limehouse," "Nocturne," "The Toilet," Mr. T. R. Way, in his *Memories of Whistler,* speaks of (p. 9) as "not lithotints, but in the 'manière noire,' the stone being prepared before he touched it, . . . with . . . half tint, upon which he worked by adding darks and scraping lights." This reduces the actual lithotints to three. (New York and London: John Lane, 1912.)

I append extracts from notes in the Way catalogue, confirming what I state in the text as to its unreliable character:

No. 7 'Early Morning.' The first state, of which 12 copies were printed, is so dark as to represent a time before dawn. The broad washes of ink laid on the prepared tint are seen to have run together in places and to have lost the drawing. . . . . There is hardly any indication of

There is a way of rubbing a washed tint with a dry rag, thus uncovering some points of the stone and giving the rolled-up tone a corresponding texture. In actual depth (value) there is no certainty that it will yield anything in particular. Practically, it serves as a basis for a sort of engraving, called "scraping."

Such scraping may be, and by Sir Hubert Herkomer was, carried on as an art complete in its own terms. It is not drawing: it is engraving. Herkomer took a crisply grained stone and pushed a mixture of crayon and tallow into all its surface, the instrument used being an artist's bristle brush. The design was then created in terms of lights scraped clearly off the summits. In combination herewith he developed, as no one else has, a variation on the usual lithographer's needle, a sharp steel pen. Thus a technical situation was brought about which is sound, consistent, and of unlimited possibilities. (See example in a monograph by Herkomer, *Some Phases of Lithography.*)

Of course, liquid ink may be used, with either pen or brush, in accenting crayon work. Pen drawings on stone may be made, but not with anything like the success of which pen and ink is capable on paper. Pens may be used of either quill or steel. The latter tends to dig the stone, get bits of it between the nibs and go wrong. I like best my own home-made liquid ink (formula on p. 20).

A finely pointed brush may be got by cutting off the outer hairs of a good red sable, but I find the best slender Japanese brushes make this unnecessary—they are as perfect as they can be.[2]

Other ways of using liquid ink on stone are with an atomizer or an air brush. Work similar in principle may be done with a toothbrush dipped in ink and made to spray its contents by being scraped over an edge—the "spatter work" of our childhood.

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scraping. The artist then took the stone in hand, and by two further states scraped away the unnecessary darks and recovered the drawing; after each scraping the subject was further lightened by re-etching. . . . ."

"No. 4 'Limehouse.' The first state is very dull and uninteresting in effect, the sky having printed far too dark, etc.— . . . . by means of the scraper . . . . re-etching, as well as some darkening of the buildings, ... the true relation of the various parts was obtained."

"No. 6 'The Toilet.' The figure was afterwards greatly lightened throughout with successive scrapings and re-etchings."

[2] To be secured from the Jap Art Brush Co., New York City.

ENGRAVER'S METHODS

A stone having been covered with grease, ink, or asphaltum may have a cut made in it as in a wood-engraving. An etch will prepare the inside of the cut, though it ought not to be necessary. A proof will now show an incised cut, white or black.

Reversing: the stone may be filmed with a gum etch through which, when dry, a cut is made and ink rubbed into it. The stone, cleaned of its gum, now prints black on white.

These methods are not properly lithography: they are, respectively, forms of relief and intaglio engraving.

Furthermore, a sort of stone mezzotint may be done. The surface covered with grease or asphalt, is scraped from dark to light, as in mezzotint. (See Herkomer's method, p. 35.)

V. STEPS AND MATERIALS[1]

TO LAY OFF A PICTURE RECTANGLE 10 BY 14-INCH ON A 16 BY 18-INCH STONE

LAY the edge of your ruler near and parallel to one of the shorter sides of the stone and dot off on the stone the central 10 inches, leaving 3 inches (be the same more or less, for the stones are never in exact dimensions) at each end. Repeat the operation at the other end of the stone. Draw from one of the dots to its mate on the other end of the stone.

This line is supposed to be parallel to the long axis of the stone, and we act accordingly. Lay the ruler along this line and mark off the 14 inches which are in the middle of it, leaving 2 inches (be the same more or less) at each end. From each end of this 14-inch line, by the use of triangle or carpenter's square, lay off a line at right angles and draw it very faintly across the entire stone. On each of these two squared-out lines measure from its beginning point, 10 inches and dot its end. Rule between the two dots thus secured and you have your 10 by 14-inch rectangle. Stones are never true to size and seldom exactly square, but this method enables you readily and with sufficient exactitude to put in the middle of it your desired rectangle. And the angles of this rectangle are true, so that when your print comes to be matted and framed, it will be right. Even if you do not intend any inclosing rectangle visibly to appear on the print, it is just as well to locate one on the stone and to keep your design in a certain relation to it. This facilitates the use of the scraper in the printing press, also the cutting of the printing paper, and the adaptation of a mat or frame later on. The scraper of the press requires an inch or two, the latter much to be preferred, outside the picture at each end of the stone. Besides, the rolling is far more conveniently done if there is a considerable margin at the sides also.

GUM ARABIC

Generally, gum arabic is used, though other gums possess somewhat similar properties. It is soluble in water and may be regarded chemically as

[1] See "Steps" and "Materials" in Appendix.

being composed of potassium and calcium salt of arabic acid. Its acid content, though imperceptible to the taste, is readily shown by litmus paper, and much alkali must be added before it is completely neutralized.

In making a solution of gum arabic, two to three parts of water to one of gum may serve as a basis, the general idea being to get an article of the approximate consistency of olive oil. Used in lumps, cold, 24 hours may be required to effect complete solution. Hot water and agitation reduce this much. If lumpy when done, strain it. Druggists sell a white, powdered gum arabic that can be stirred up into a solution at any time in a few moments. It is a great convenience, and reduces the temptation to use sour gum. Any gum solution sours in time, and its sourness is non-beneficial to the work on the stone. Oil of cloves, eugenol, spirits of wine, or carbolic acid, will keep it from souring.

For the purposes of the lithographer, the best gum arabic is said to be that called in the trade "Senegal." Other kinds, however, serve the purpose, and the commercial lithographic houses generally use that named "Kordofan."

VARNISH

Varnish is a generic term, but in our usage refers to those vehicles or binders that carry the pigment of printer's ink. These might be made of any drying-oil—tung oil, soy-bean oil, corn oil, poppy oil, nut oil, or linseed oil. Linseed oil is, however, the usual article, though both soy-bean oil and tung oil have interest in this connection.

In its natural state linseed oil is so thin that it spreads on paper and would certainly spread on stone. To stop this we thicken it by heat. When thickened, it is called "varnish." For the finest varnish, the oil should be of the best, cleaned of impurities, and not too fresh. Such oil, heated to the flash-point and set on fire, is burned, with constant stirring, until the desired thickness is attained. Hullmandel directs that when one-sixth of the bulk has burned away, we are to insert and fry well a thick slice of bread, then burn a moment more and fry a second slice. Onions, also, used to be put into the boiling oil, adding brilliancy and drying quality to the product. Aside from, or perhaps in process of, thickening the oil, the burning and bread-frying free it from an objectionable element known as "grease." Mr. Hengstler (Meyer & Co.), an experienced manufacturer, tells me he heats oil for 10 hours to above 600° F., thus causing the "grease" to be driven off by volatilization.

PLAY

Size: 13×8¼ inches.

Stone number: 465.

Drawn with a brush carrying ink of the following substances and in (approximately) the following quantities:

Babbitt's Concentrated Lye (saturated solution)	20 drops
Oleic acid	15 drops
Lampblack	enough to make a solid black

These are rubbed together with a spatula on a slab. Add water to get consistency wanted.

being composed of potassium and calcium salt of arabic acid. Its acid content, though unperceptible to the taste, is readily shown by litmus paper, and much alkali must be added before it is completely neutralized.

In making a solution of gum arabic, two to three parts of water to one

approximate consistency of olive oil. Used in lumps, cold, 24 hours may be required to effect complete solution. Hot water and agitation reduce this much. If lumpy when dissolved, strain it. Druggists sell a white, powdered gum arabic that can be stirred up into a solution at any time in a few moments. It is a great convenience, and reduces the temptation to use sour gum. Any gum solution sours in time, and its sourness is non-beneficial to

acid, will keep it

PLAY

Size: 13×8½ inches.
Stone number: 495.
Draw with a brush carrying ink of the following substances and in (approximately) the following quantities:

Rabbit's Concentrated Lye (saturated solution)	20 drops
Oleic acid	15 drops
Lampblack	enough to make a solid black

These are rubbed together with a spatula on a slab. Add water to get consistency wanted.

oil, corn oil, poppy oil, nut oil, or linseed oil

the usual article, though both soy-bean oil and

oil is so thin that it spreads on paper and

thickened by heat. When

For the best varnish, the oil should be of the best

flash-point

with constant stirring until the desired thickness is

of the bulk has burned

bread, then burn a more

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to the product. Aside from, or

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shown as "grease." Mr Hengstler (Meyer

tells me he heats oil for 10 hours to above

the "grease" to be driven off by

oxidization

PLAY.

When, according to Hullmandel, the oil has been treated as described, a drop is cooled, and if it shows a syrupy nature it constitutes varnish No. 1. A quantity of this is laid apart. Successive burnings yield increasingly stiffer grades, Nos. 2, 3, and 4, the last being "thick and ropy." These numbers vaguely correspond to the names in use in England—thin, middle, stiff, and extra stiff. In America the English "middle" is about No. 4 or No. 5. But the numbers, with us, do not accurately indicate the same thickness when made by different firms. In London I got good varnish of Corneillissen; in New York I buy chiefly of F. W. C. Carter what he calls "Regular Burnt Litho Varnish." Most of my prints were made with Nos. 3–6 of this varnish. The differences vary as the temperature changes and also somewhat according to the nature of the design and of the particular paper employed.

When I was an etcher, I used to make my own varnish and ink; but as a lithographer have found no need to do either.

PRINTER'S INK

The ingredients of ink are a colored substance and a binder. The pigment is most commonly lampblack, though there exists a new patent black pigment which is an iron oxide. Lampblack is simply fine soot, secured from the smoke of burning oils, fats, or waxes. This soot tends to contain a little oil which has been volatilized from the burning substance by the heat. To get rid of this the lampblack is severely baked, a process called "calcining."

Ordinary lampblack is not so black as the carbon from burned gas, but for us it is better on account of its greater amenity in mixing with varnish, and its extreme fineness and silky working quality.

The best vehicle for our ink is probably a pure linseed-oil varnish. This is what the market claims to use. Some use a thinner and some a thicker varnish. For our purposes, that made of thicker varnish is to be preferred.

Ink for printing crayon lithographs is sold in cans, a substance so stiff that it has to be gouged out with difficulty by the help of a strong knife. It is labeled "Best Chalk Litho, No. 1," or words to that effect. I have used that by Robert Mayer, of Hoboken; and that by Fuchs & Lang Mfg. Co., of New York. In London, Corneillissen's.

THE DAMPING-WATER

From time immemorial, lithographic printers have been tinkering with the water used in damping the stone. Ale, tobacco juice, and slops even more offensive, have been used. None of them is necessary.

Water itself is the basic element in keeping the stone clean, although it may, on occasions, be made the vehicle of chemicals affecting the action of the ink as you want it to be affected. Honey, molasses, and sugar each has the power to make the ink go down on the design more readily. Containing no fat or soap, these cannot molecularly react with the stone, but only colloidally. Used by inexperienced hands, they can, however, by overdoing their function, bring about clogging and smut.

I drew a nude[2] enveloped in faintest atmospheric tones. Instead of gum, I treated the drawing with pure honey. The roll-up was incredibly overready; and in printing the edition (thirty), the rolling throughout had to be done at entirely abnormal speed. Impressions were perfect.

In hot or dry weather, if the stone works too dry, put into the water glycerine or salt, the latter preferred.

If the stone is disposed at any time to run smutty, a trace of acid in the water helps. The best I find to be a few drops of 10 per cent phosphoric acid. Added to 2 quarts of water, 2 drops of this will have a clearing effect. More may be used. But with too much, there begins a tendency for the bloom to disappear. To avoid this, use the device only till the stone is cleared.

Phosphoric acid, mentioned by Senefelder and today used in etching planographs on zinc and otherwise, does not remove part of the surface of the stone as other acids do. It seems to make a deposit, a coating unimaginably thin but singularly effective in discouraging grease adhesion. I think of it as amorphous phosphate of lime. I use it locally, mixed with gum, to correct smut. When another acid is used, it is necessary, after etching away the smut, to gum down and dry the place—an operation not needed when phosphoric acid is used. Sometimes I have used it in place of other acids when treating a stone preparatory to printing. I have in other cases pulled editions in which no other acid was used. "The Model Reads" was done in this way.

Another thing I discovered the use of in damping-water is mineral oil,

[2] Reproduced in the *International Studio,* LXIX (1920), cviii.

or, if this is too thick, a trace of heavy naphtha. The idea of oil in the damping-water is intrinsically horrible, I know; but the truth is this substance merely calls itself an oil and in reality is a sort of liquid paraffin wax, possessing no fatty acids or ability to combine with the stone at all.

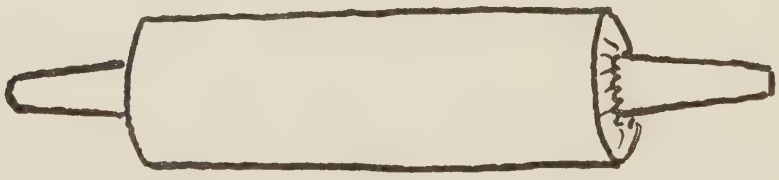
I have been printing a very rich design on unsized genuine India paper, pretty damp, thin, and of course unutterably tender. The tendency for the ink to pull off bits of it was pronounced. I dared not, however, thin the ink lest I lose the velvet by clogging my blacks. By adding to the damping-water a very little mineral oil, the adhesion was reduced and the edition carried on perfectly. This was not an occasional freak performance but a thing done many times.

VI. THE ROLLER

THE ROLLER: ITS MAKE-UP AND CARE

THE real secrets of lithography," writes Raucourt, "exist in the process of printing." True, and this process hangs absolutely upon the virtues of the roller and the skill of its user.

To make a roller, a 4-inch block of beech or other wood, very thoroughly seasoned, is put in the lathe and turned into a cylinder whose elements have the faintest trace of convexity. Holes are bored into the ends and handles inserted. The roller is now jacketed with one or more layers of a special flannel or felt. Over this is drawn a previously sewed, tightly fitting sleeve of thick, soft, dry calfskin with a delicately buffed surface and as porous as blotting-paper. If properly used, the working qualities of a roller



improve with time. Usage may stretch the leather so that it slips on the cylinder. The correction for this is to have another flannel put under it. Or, its seam may be opened and a cut taken from the leather. The seam is sometimes made a spiral, to minimize the jolt in rolling over it.

The length of the roller is optional. For that matter, so is the diameter. My favorite is 13 inches long, 1 inch smaller than the standard. Professional printers like a heavy roller, its weight saving them some labor of pressing down. Personally I like a light one, and the one I use most is of basswood. A roller may last twenty years, or if ill used, it may be ruined at once.

In buying a roller for fine crayon work, select one with a medium degree of roughness or nap on the leather. As this wears off, the roller will become less shaggy and more like velvet, its ideal condition.

A new roller should first of all be bathed with castor oil or lard or

some other strictly non-drying soft grease. When it will take in no more, scrape off the excess and roll it on the slab in medium varnish. Roll long and well. Much fuzz will come off, which you must scrape from the stone, repeatedly, and go on rolling. Hang up the roller by its handles and leave it overnight. Repeat the rolling, with a clean slab and new varnish.

Finally, scrape the roller itself, apply stiff varnish to the stone and roll in that—long and hard—again removing the new crop of detached fluff. Following this, ink may be made, the roller charged, and printing undertaken.

When the day's printing is over and it is time to put away the roller, place one end against the table and the other end against your body and, holding thus, take the opposite ends of the ink knife in your two hands, as if it were a drawshave, and scrape off the excess ink. Go once around it, scraping *first* in the direction which is against the grain. Turn it end for end and repeat, scraping now so as to lay the grain of the leather down. Put it by in a dustless place, supported only by its handles. Waxed or other paper around it will both keep dust off and retard hardening. This is the way to treat a roller you will use again soon. If it is to remain unused for a week or more, smear the surface with lard or a similar non-drying article. Aside from the question of its lying by, some printers recommend the practice of dressing the roller once a week or so, anyway, with lard, butter, or perhaps a mixture of thin varnish and neat's-foot oil, just to keep it very soft. Of course, these preservative dressings must be scraped off with thoroughness before you use the roller. Speaking generally, the roller is always scraped the smooth way of the grain. I sometimes add to such a scraping a washing with naphtha. The degree of care necessary in all these things depends on just what you have first to print. Some stones are ten times as exacting as others: it all depends.

If in process of time the roller gets hard, it may be cleaned with solvent naphtha, benzine or kerosene, or linseed oil. If the surface seems dead and wants livening up by friction, use salt with benzine, or the like. The liquid is a solvent; the salt is a mechanical abrasive, its advantage being that it dissolves out in water as a mineral abrasive would not. Turpentine is said to harden the leather.

THEORY AND PRACTICE OF USING THE ROLLER

Rolling over a plain of little hills, it is necessary that the roller's surface should be soft enough, and its backing elastic enough, to allow it to go down into the hollows between the hills and apply ink even to the bottom of them. This explains the construction of the roller and also shows why that printer who allows his roller to grow hard will not get perfect impressions.

A curious part of the theory of the roller was first shown me in my early days by Mr. Corneillissen, who played with rollers in his cradle. "You must not," he told me, "fill the leather so as to shut up its pores; for this leather is tanned specially so as to take up water from the stone, like a sponge. And when you roll, as the stone dries, you have a sort of reservoir in the roller which helps keep the stone damp." I felt sorry for the man, for, in my ignorance, it seemed to me impossible that a roller soaked and loaded with heavy varnish should take in any water at all. But of course, as I gradually found out, he was right: the inkbestuck roller does take up water, it does hold it in reserve, and when rightly handled does give it out again, so that, simultaneously with performing the function of an inking-roller, it also performs that of a stone-dampener. The governing secret is the degree of moisture you start with and its relation to the pressure used: little pressure takes up water, if any is present; more pressure squeezes it out.

An element affecting the moisture film on the stone is the roller's speed —more especially, of course, when the film is very thin. In this case swift rolling acts as a fan: working in conjunction with the repulsion exercised by the ink on the lines, it tends to get the dryest place on the stone exactly where it is not wanted, i.e., close along the edges of the lines. And if this is continued, the result is the attachment, by little and little, of ink beyond its proper chemical spot, along which road quick ruin lies.

On the other hand, easy as it is to spoil a stone by quick rolling, it is no less easy to spoil it by the opposite action; and if you move the roller slowly enough it will, from merely the slowness, foul the stone. The law is that, so long as the surface is sufficiently moist, the greater the speed the less the tendency to smut. However, as our object is not merely to avoid the action of inking the stone, but must be, at the same time, to produce the action of inking the lines, we must learn to recognize that middle ground in which these objects may be accomplished simultaneously. The general principle to be grasped is that adhesion—whether it be to stone or to ink—is encouraged by the same things and discouraged by the same things.

Transference of ink from roller to drawing is favored by slowness of rolling, hardness of pressure, horizontal drag, sidewise thrust, dispersion of ink on roller, heaviness of load on roller, and thinness of the ink. A trace of sugar or molasses in the damping-water works in the same direction. Also, for similar results, there may be added to the ink sundry substances called "ink doctors"—turpentine, wax, tallow, soap, linseed oil, terebene, palm-oil, etc. A proprietary article sold as an ink doctor I bought was a mixture of soap, tallow, and Japan wax. I sometimes use mineral oil, heavy naphtha, vaseline, or paraffin, according to effect wanted.

The usual purpose of an ink doctor is to decrease the strength of the ink's adhesion, which effect is shown by the reduction of the length of the threads into which the ink may be drawn. Ink thus treated is a "short" ink; its feeling on the slab under the knife is different; its noises are softer and less snappy.

For an amateur, I advise restraint in tinkering the ink. Probably his safest try would be with a little vaseline or mineral oil; not much, or it would interfere with the drying. A bulk equivalent to a grain of wheat will do a good deal.

When it is desirable to keep the ink very stiff to avoid squashing, and yet to reduce its adhesiveness to keep it from tearing the paper, I use paraffin. Some manuals refer to an operation called "knocking up the ink," which consists of rolling the ink slab a number of times, and very swiftly. The effect is to pull up the nap on the roller, to agitate and respread the ink, and to make both ink and roller dryer, for these are both continuously getting wet from the dampness of the stone. In consequence of these changes the roller now causes the ink to adhere to the design with marked readiness. It is in this act, which we can perform at any moment and to any degree, that we have our easiest and most constantly used means of controlling the passing of ink from roller to design.

Typical usage of the roller is as follows: It is worked on the slab: a roll is made over the stone, another and another, the ink being deposited in accumulating quantities on the work. The deposit, however, is less and less as the roller gets damper from the stone and smoother from rolling on it. Along about the sixth roll, supposing the stone is not drier and no extra speed or pressure is used, no further deposit takes place. To secure it, some of the influences mentioned above must be called into action.

An exception must be noted to the rule that as the water on the stone

grows less the ink is affixed to the lines with more and more readiness. It was a long time before I discovered it, and it is not mentioned anywhere. This is it: Dampen normally and roll—twelve, fifteen times, or whatever is needed for complete loading. But here a complication arises, for you have set out to get the drawing loaded perfectly, preferably by a minimum number of passes, and the last perfection is only possible at the moment the stone reaches a particular degree of dryness; consequently, if, when you have made the requisite number of rolls, the stone has not yet reached this degree, you have nothing to do but keep on till it does. It would naturally be supposed that the printer could merely stand still until the drying of the stone caught up with the rolling. This, however, will not do, for the continuous rolling is the very thing that keeps the moisture distributed evenly, which very evenness is what enables the film to be allowed to reach a high degree of attenuation while yet safe to the roller. Besides, a part of your judgment regarding the state of the stone is based not on its appearance but on its feeling under the roller.

If you inadvertently let the stone get too dry, it will of course roll black all over and be at once and forever ruined, unless you know what to do and do it instantly. The thing to do is to wet the stone, rapidly and thoroughly; then, instantly and hard, work the roller on the stone. The ink which is not attached to the lines will be pulled off the stone by the roller—leaving it clear again. Be it noted, however, that this is a dangerous business and should never be allowed to happen.

We noted that pressure favors adhesion. Now, because of this, a good printer, who knows that no single impression can be pulled for itself alone but must fall in with such treatment as shall preserve the stone, tries to get along with as little pressure as will serve the purpose. Remembering that the drawing exists as spots on the stone, he will try to ink these spots with the minimum of danger of inking the spaces between them. He may do this by substituting for direct downward pressure a more or less horizontal dragging tension. The grip of the fingers on the leather handles produces a drag, the force of which is transferred to the line of contact between the roller and the stone and causes the ink to adhere. Endwise pressure, in the direction of the roller's axis, has the same effect. This drag, or horizontal pressure, is what makes necessary the leather covers for the roller handles.

When ready to print, dig out as much hard ink as equals a globe of

half an inch. Add perhaps a fourth of this quantity of varnish, *mix down well* with the large knife, and work out with the roller until the ink is thinly and evenly distributed.

Clear impressions, as well as good editions, are favored by a reasonable stiffness of the ink. The roller, passing over the inking-slab, makes a gentle hissing sound, like a cascade of water a little way off. It is too stiff to drip from the knife, yet a steep pile of it may tend to flatten a little by gravity. Excessive stiffness necessitates great pressure in applying the roller to the stone, which pressure has some tendency to shorten the life of the stone. Years ago, when I began, I used a No. 6 varnish almost exclusively, but I have gradually adopted softer ones until now I use more No. 3 than anything else. However, much depends upon the paper, and my adoption of the softer varnish has partly come about from my using papers of greater and greater tenderness. My ideal is to build an ink that will go down on the design quite perfectly with the minimum pressure and a convenient speed. Such an ink gives the greatest length of life to the stone and makes printing it both easy and rapid.

Ink is whimsical stuff. A very little dust may injure its performance. Dampness, which it acquires from the stone, also affects it. The roller will sometimes get so damp that it will not take up any new ink from the slab, but rolls over it without any adhesion at all. The cure is to go on rolling, rather swiftly, which soon dries away the water film, and the ink sticks again.

The constant rolling upon the ink-slab gradually works the ink out to its edges, which, reducing the load on the roller, naturally brings about light impressions—often to the complete mystification of the novice. The remedy is obvious: scrape the ink back where it belongs, or, better yet, throw it away and mix fresh.

If undue quantities of ink are in use, the excess which the stone may be induced to take will tend to a gradual enlargement of the spots by repeatedly inking them larger than they are. If this goes on, the immediate vicinity of each spot acquires an affinity for ink, which affinity increases by what it feeds on; and the end is the loss of the granules of light in all the darks—thick harsh impressions; and, in short, the stone, in the elegant phrase of our craft, is "bunged up." If in ordinary hands, it is ruined.

However, if this mushrooming of the ink spots is detected early, and if the stone has remained constantly wet while this has been going on, then

the extra ink has not had an oportunity to take any real hold on the stone and the trouble can be dealt with. If, on the other hand, the stone has at any time dried while in this state, then the ink will have attached itself definitely and can be got off if at all, only by tedious and ticklish abrasions with cuttlebone—practicable only to very skilled hands.

Returning to the first case, where the stone has not dried: the first prescription is to wet the stone, thoroughly mix some very strong ink, and roll swiftly. If this clears the work, well and good; gum up, dry, wash off gum, and continue to print—but using stiff ink and working not too slow. If, however, the trouble is too far advanced for this to be effective, mix equal parts of turpentine and water, and half fill a bottle with it. Shake well, throw it upon the stone, and wash it about.[1] The water wets the stone; the turpentine dissolves the ink. Clear away the mess with water and roll up. Gum and dry the stone, after which it should print as at first. If there were any doubtful elements in the problem, it would be safer, after the washout and roll-up, to pull a print or two, then roll up, then add a very faint trace of acid to the gum, gum down, dry, and not print until the next day.

A stone may be injured or even ruined merely by sluggish work with the roller. To avoid this, start the inking for each new pull—on each freshly dampened surface, that is—with two or three slightly brisk passes, the effect of which is to clean up the stone, giving the new inking (which an immediate slowing of the roller allows to begin) a fresh and true base to start itself upon.

An application of gum has at all times a very slight tendency to clear the stone. Passages in the design too delicate to be tinkered with by anything stronger may be sometimes cleared—it may be, repeatedly—with pure gum.

Where more decisive measures are needed to clear a cloggy stone or passage, we have, of course, the resource of putting a trace of acid in the gum. By increasing this trace, we can remove anything, the question being if we can refrain from removing what ought to remain. As previously mentioned, phosphoric acid is good for such uses, one part of 10 per cent acid to from fifty to two hundred parts gum solution, according to needs. The best way is to coat the whole stone with the gum and into that, where wanted, paint the acid-gum preparation with a little brush. The etch is thus perfectly controlled and localized, while yet you avoid forming any definite edge to your field of operations.

[1] Senefelder gives these directions.

A stone that is acting badly will sometimes recover its health, so to speak, if simply rolled, gummed, and put away for a few days. This is the professional idea and practice. However, it has been my experience that it is better not to leave the stone put away for more than a few days, otherwise a slight coarsening of subsequent proofs may result. When work is large in scale or without fine textures, these considerations matter less. Some printers, in gumming down work for future printing, use a very little acid in the gum, to counteract this tendency to print heavier next time.

A design may be made to print darker by leaving it, after a few proofs, dry and ungummed—what the professionals call "open"—for a few minutes or hours—the time increasing as you want greater darkness. Naturally, this darkening is accompanied with some degree of coarsening.

VII. PRINTING

THE FUNCTION OF PRINTING

BEFORE committing yourself to the enterprise of translating a work on stone into a print on paper, stop and think just what is the true relation between these two things.

The function of the drawing is to define the artist's intention in regard to every line and tone.

The function of the printing is to reproduce this defined intention by reproducing the drawing.

Says Hullmandel: "The best rule to follow is to make the drawing as nearly as possible what it [the print] is intended to be" and "the impression, as much as can be done, similar to the original drawing."

Says Thomas R. Way: "The printer's work ought to be, as it can be, a simple and regular repetition of the proof."

Exactly!

Draw when you draw: print when you print. Do not try to draw with the printing press: the crayon is the better instrument. Persons who really can print—that is, who can perfectly reproduce a drawing—know this. Persons whose attempted reproductions slide all up and down a scale try to jolly themselves and others into believing that this is a merit, that there is something peculiarly "artistic" about not knowing what the press is going to do next. Really, they are cloaking their inadequacy by calling that a virtue which is but an unwelcome necessity.

THE WASHOUT

Washing the crayon or ink off the stone with solvents in the presence of water—leaving the design to exist only as a more or less faintly visible chemical spot, which, after such washing, is rolled up with fresh ink—is known as "washing out and rolling up." Its object is to get the printing surface of the stone cleared of any material that interferes with getting good prints. We print *with* printer's ink, and we print *from* a chemical spot on

THE COW LOT

Size: $11\frac{15}{16} \times 8\frac{1}{2}$ inches.
Serial number of stone: 556.

the stone, and the ideal condition is that in which only this ink and this spot are present. The existence of crayon on the stone, underneath the printer's ink, as may be the case when a drawing has been rolled up on the crayon, while not rendering printing impossible, is superfluous, and, on account of the possible occurrence in the crayon of traces of unneutralized soap, sometimes objectionable. When printing is started without washing out the crayon, what happens is that the first batch of prints are all bad, because of the mechanical influence of the crayon, and, more particularly, of the resin in it; and not till the crayon is gradually worn off do fine prints come. Some think starting editions in this way has a peculiar mystic merit. Mr. Pennell picked up this idea somewhere and embalmed in his book the false statement that a design does not fully return after the washout. Every printer, myself included, washes out all the time. The washout is simply a cleaning of the stone, nothing more nor less; and a clean stone prints better, easier, and longer than a dirty one.

THE ROLL-UP

The stone being wet, following the washout, begin by rolling gently, rather slowly, and without horizontal drag. Begin while the stone is yet pretty wet, and stop some time before any part of it is dry. For a long time I was much bedeviled in the roll-up by the advice in the handbooks about specially soft or peculiarly composed inks for it; but in the end, after a wilderness of this, I proved that nothing of the sort is either necessary or desirable. All that is wanted is freshly mixed ink in ordinary quantity and consistency or possibly a little soft; a good roller in perfect condition; and in your head a sound theory of what you are about—these will give a roll-up impossible to improve.

In the roll-up, the ink sometimes seems to contain, in spite of all pains, a trace of an oily element that separates out and crawls as an iridescent film on the water wherewith the stone is wet. If, in such a case, the water carrying the film is washed off with fresh water, no harm follows. If, on the other hand, the water carrying the film dries, then the film settles down and attaches itself to the stone and gives a "halo" when you print it. It is sometimes undesirable to sluice the rolled-up stone with water, in which cases the protection against halos lies in rolling till the water is so nearly exhausted that not enough remains for the film to crawl out on.

MAKING THE ROLL-UP VARY

To roll a drawing for a medium print, mix one part gum solution with ten parts water. To an ounce of the mixture add one to three drops of acid. Flood your stone with this. It will not etch appreciably: it will harden the crayon. You roll, in this liquid, then dry, resin, and etch. Allow, after applying the foregoing wash, about a minute to elapse before rolling. Owing to the small amount of gum present, care is required in the handling of the roller. However, once the roll has commenced, a little extra gum may be added if needed.

For a rich dark print it is possible, by using lots of water and lots of speed, to wash off the drawing completely, and then, with perhaps the addition of a trace of gum, to roll up. Among my published lithographs are some that were done thus, but it is a mere stunt—certainly not suited to a beginner.

A way to get a stone to roll a little darker than the drawing is simply, after the first roll-up, to let it dry, re-wet it, and roll again. Still another way is to start printing before etching, or after a very faint etch—each proof will come darker than its predecessor. When the stone is as dark as you want it, dry, resin, and etch fully. Obviously this last method may be applied to different parts of the stone in different degrees, thus making parts print darker than other parts, according to which was etched first.

If a stone is left ungummed—"open," as it is called—after being inked, it will gradually spread. Thus a stone left open an hour will roll darker than before. Also, a part may be open while the rest is kept wet, or gummed.

It is necessary here to discuss somewhat this matter of printing, or of rolling up, the same design lighter or darker. As I have already formulated the essence of the matter in my essay on *Lithography* (Fitzroy Carrington, 1923, p. 15), I will quote it here:

> There is something to be said about dark impressions from the same stone. From the very beginning of the practice of the craft—you will find it in books—there has been misunderstanding on this point. The assumption has been that when you pull a lighter and darker impression you have got the same thing only in different keys of light. This is not true. There is no such thing as shifting the light key without some shifting of other things, without changing in some degree the tonal and textural relations that affect fundamentals. Why and how this is, I will explain.
>
> For every stone there is such a thing as a normal print. This is the print that gives on the paper the image of each granule on the stone, truly duplicated as to size. To get a print that is darker than such a one, we must put more ink on the stone

and this ink must go somewhere and somewhere where it was not before. Where it goes is around the edges of each printing spot, the consequent enlargement of which darkens the impression pulled. But—and here is the kernel of the matter—this overhang of ink in excess of what the stone calls for does not distribute itself around the edge of each spot in proportion to the size of that spot; if it could do this the tones of the drawing would maintain their original relations: it distributes itself in a band which has the same width for all sizes of spots, with the result that a band that enlarges a spot by one tenth of itself, enlarges a spot of one tenth this size by relatively ten times as much. . . . . Two results necessarily follow: the small spots being enlarged relatively more than the large ones, tones composed of small spots, wholly or in part, are darkened relatively more than tones composed of larger ones: the textures composed of small spots are coarsened more than others are. In a word, if we go on pulling darker and darker prints, we constantly remove the light tones farther from white paper, while the blacks, being black, remain stationary. This shortening of the light-range crowds delicate intervals out of existence, and weakens strong ones. Lights, unless pure white—and these stare—no longer count, and dark accents no longer have snap. The condition referred to by Senefelder as "monotonic" is brought about. Followed to its full possibilities, what was an ordered set of varied tones and textures becomes a mass of clotted silhouettes.

Matters fall out much the same if we shift the normal printing key to a lighter one. To get a light print we must, by under-inking or under-pressure, get simply an imperfect and rotten impression, carrying falsities of value and texture all over it, or else we must lighten the stone by acid, an act which, just as over-inking did, affects large and small granules unequally. Thus tones are again upset, textures coarsened, and the visual balances created by the artist destroyed.

VIII. ETCHING THE STONE, AND RELATED MATTERS

ETCHING THE STONE

This is one of the most important tasks a lithographer has to perform.

—Vincent Brooks

PERHAPS the best way, at this point, is for me to write first a simple set of directions, easily followed, and after that refer to the chemical theory. However, there are, it must be premised, many ways to treat a stone—some suitable to amateurs, others to experts; some to one kind of work, others to a different kind. I have chosen one which a beginner would be most likely to succeed with.

This method differs from that of the commercial or, for that matter, the artistic printer. Perhaps I invented it. Certainly I evolved it, as a home product, in my search for finer prints. The books, even the technical encyclopedias (the *Encyclopaedia Britannica,* etc.), as well as every printer I know, all agree that the way to etch a crayon drawing is to put the etch directly upon it. This is supposed to, and does, "harden" the crayon. The theory is that this hardening is necessary before it can be rolled up. Naturally, I began with this same theory, though it is so long now since I abandoned it that I have to search my memory to bring it back.

What I do now is exactly to reverse the order of operations, putting the rolling first and the etching second. The initiated stare, when they see it done; but they admit its success. That this can be done proves that the theory that unetched crayon cannot be rolled up is wrong. Not only my own crayons, but any crayons whatever, I treat this way, and with equal satisfaction.

What I direct the student to do—gum down and dry before rolling—I do not, in my own practice, find it necessary to do. But it is better for him, as a beginner. One reason is that the gum itself "hardens" the crayon; and

another is that, having been dried on the stone, the latter is thereby given a "preparation" against soiling from the inky roller.

As previously stated, it is possible—all tradition to the contrary notwithstanding—to roll up a stone in the absence of any dried-on gum preparation, using merely a little gummy water. Indeed, I have sometimes gone even farther, rolling a stone perfectly with no other protection than water alone. It is all a question of skill and the strict observance of simple but rigid conditions.

However, as a novice, begin according to directions—by gumming and drying. Have no fear that the wet gum will spread the crayon. It can't, for the moment the gum touches the stone this becomes impervious to crayon. Also, in a very few seconds the gum, even before drying, has made the crayon practically insoluble. And lastly, no harm would follow the dissolution of the crayon or even its entire removal.

Nevertheless, it is possible to get smudged drawings in the operation of gumming down. What happens is that the hand, or anything else, in spreading the gum, overruns the gummed parts of the surface and rubs parts of the drawing not yet under the gum. It will not show at the time; and when the later roll-up brings these smudges into visibility, a novice would naturally think they had been formed under the gum, but quite mistakenly.

Having then applied your gum, smooth it out with your hand, drive the excess off the edge of the stone, and let it dry. The object of thus doing away with the excess is to get a thinner coat, and the object of the thinner coat is to reduce the chance of its cracking. A little sugar in the gum will prevent cracking. Cracks are not always very serious in their results, but none of us care for them. They occur most over the blackest parts of the drawing. Another way is to use a rather thin gum and only a little of it, this being wiped out with a dry cloth into a coating having no appreciable thickness and hence incapable of cracking.

In its gummed state the stone may be put away and left indefinitely. Or, it may be taken in hand at once.

Whenever it is taken up, the next act is to wash the gum off with water, and upon the wet stone to roll the ink-charged roller, thus covering the crayon design with a top dressing of printer's ink. This operation is called "rolling up" (see p. 55). When fully rolled up, fan dry. Dust powdered resin upon the inked design. I use my hand, gently, to help the resin stick

to the ink. Dust away the excess, i.e., all that will come away. A wad of cotton batting works well for this. Dust French chalk (talcum powder) upon the resined work, treating it exactly as you did the resin. Now you have given the drawing a coating of ink, resin, and talcum, sufficient to protect it from being eaten away by the etching, which now follows. (See "My Personal Usage," p. 65.)

An amazing diversity of opinion, among practical men, exists as to how long the stone should be left after etching before printing. One says two weeks. I have left it seven months. Others speak vaguely of a few days. Hullmandel says the longer the time the brighter the prints. Herkomer says twelve hours. With my own chemical and physical methods, I doubt if anything important happens after the first few days; and for ordinary purposes, I consider that overnight is enough.

The next step, again, varies with different printers. My present practice is to wash the gum off with water, and then, upon the wet stone, pour not turpentine and sweet oil as Senefelder directs, but pure solvent naphtha. Sometimes I add a very little linseed oil to the naphtha. Turpentine may replace naphtha. Sometimes I add a little kerosene to the naphtha or turpentine. This promptly dissolves the drawing, and I sluice the black mess off the stone with plenty of water. I finish by swabbing the stone with clean water, using a clean rag. I leave but little water on the stone, yet enough.

I now apply the roller and ordinary printing ink, perhaps a little softer than usual; whereupon the design promptly reappears. If it has not yet come perfect when the stone threatens to become too dry, I dampen the stone anew, recharge the roller, and continue to roll until it is perfect. It may take perhaps a minute. I fan the stone dry, apply talcum as before (no resin), and then spread over all a thinnish coat of gum. Here the function of the talcum is merely to check the repulsion of the gum from the greasy lines.

I generally, at this point, let the stone lie until the next day, thus giving the ink, now that the crayon has got out from under it, a chance to work itself into the pores of the stone where the fatty acids in its oil will continue slowly to combine with the alkaline limestone, thus deepening and strengthening the chemical work already done by the crayon. The longer it lies, the surer will it print.

Suppose you start to print the following day. The gum being washed off, we have the choice of rolling direct upon the old ink, and so printing,

or of first washing the old ink away with a solvent, and rolling fresh ink upon the cleaned drawing. The chief difference will be that if you print without washing out, a number of poor impressions will come first, owing to the hard old ink, which, however, ultimately wears off and all goes well. Much depends upon the nature of the design, as also upon the kind of paper used and its exact degree of dampness. If, on the other hand, you begin by washing out, you can pull perfect proofs from the first. Particularly in the case of printing on the genuine India paper (of which I at one time made extensive use), the tenderness of the unsized paper makes it well to get rid of the old ink which, if retained, frequently pulls holes in the paper.

DISCUSSION OF THE THEORY AND PRACTICE OF ETCHING THE STONE

What have we done, and why?

We have chemically coated the entire surface of the stone with something different from the bare stone. One part of the coated surface, that which was treated with crayon, will take ink and refuse water; the other part, that which was treated with gum, will refuse ink and accept water.

Greases, waxes, and resins are largely compounds of fatty acids and chemical bases.

An alkali (chemical base) mixed with a fatty acid produces a soap. Household soaps made from lye (alkali) are grease-soluble and water-soluble. On the other hand, grease and lime form soaps that are insoluble.

For convenience, we may group acids into harder acids, using stearic as the type of these, and softer acids, using oleic as the type of these. Tallow is composed of both of these, but of stearic acid (stearine) predominantly. In a drawing made with a crayon containing stearine, this unites with the lime of the stone forming an insoluble compound variously called a "lime soap" or "calcium stearate."

Other acids than stearic acid, all the resinous acids in various resins, similarly unite with the limestone and produce a similarly insoluble and lithographically printable spot. This spot it is (which is not grease but insoluble lime soap) that forms the basis of our printing. So long as this is uninjured—and it is almost indestructible except by physical violence or powerful chemicals—perfect proofs can be pulled. I have washed a stone, over and over, with solvent naphtha, scrubbing it well with a cloth until nothing

whatever was visible of the crayon design, yet upon rolling up, a flawless design reappeared and flawless proofs were pulled.

Once I grasped these facts, the old idea that the crayon must be so used as to give it a mechanical hold on the stone, and also its fellow-idea that the printing must assume the existence of "grease" in the stone (retained by mechanical adhesion), exploded and took their place as technical myths. And the old notion, first given out by Senefelder himself, that a newly made crayon drawing should be allowed a measure of time to soak in, as well as the notion that a newly made transfer must lie by for the same purpose, passed into the same category.

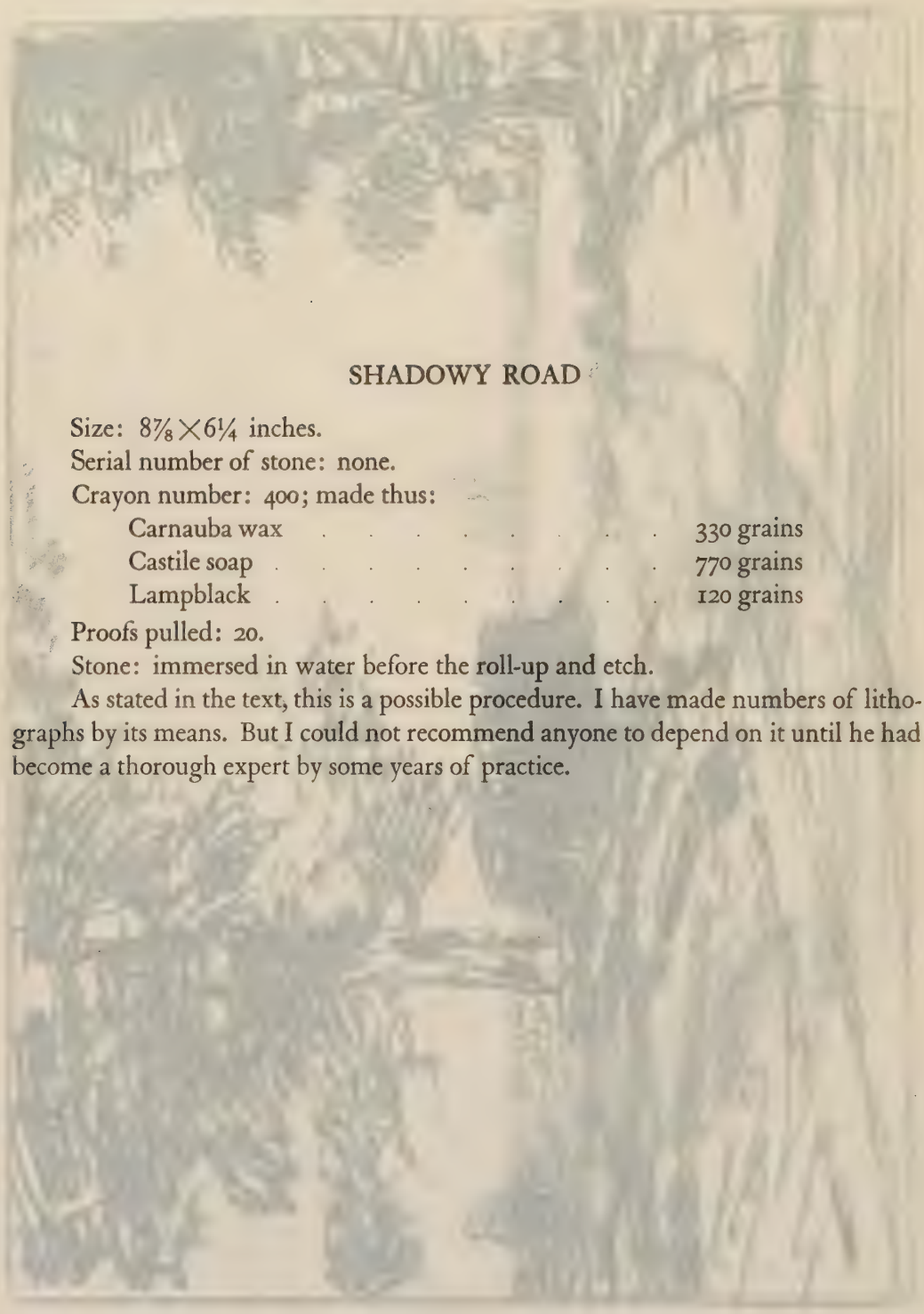
So much for the formation of the printing spot, the business of which is to resist dissolution in either the water we dampen with or the solvents we clean the stone with, and to which the greasy ink adheres when we print. Of the two divisions of the stone—that which prints black and that which prints white—this is the first.

In taking up the consideration of the second part, that which prints white, I would refer again to the generally underestimated fact that gum itself affects both crayon and stone as if it were an acid. Arabic acid is the name given to its acid content; perhaps it has something to do in the formation of the grease-resisting coat we call "preparation." For some reason, the nature of which is to be sought in colloidal chemistry, this combination of gum and stone does not become a fixed one until we have dried the gum on the stone. Having dried it, you dissolve and wash away all that has not entered into a fixed union with the stone; but that which has, no ordinary washing will remove. It forms a strictly superficial, yet singularly effective, coat that can be wetted and which, when wet, resists the adhesion of printer's ink.

A stone thus prepared, with only a gum coat, may be rolled and printed from. But only for a few impressions. Without extraneous acid, gum forms but a filmy and delicate preparation: with added acid, converting it into the regular "etch," it forms a remarkably durable one.

The function of acid in the etch is to assist the stone to accept a better gum preparation. It serves no purpose in lowering the surface, though many think it does. Neither has it any practical importance as "hardening" the crayon, though the contrary is laid down in all the books.

The more a stone is etched, the cleaner it prints, i.e., the *stone* prints. But in reality, the bare stone does not print at all—it refrains from printing—



SHADOWY ROAD

Size: 8⅞ × 6¼ inches.
Serial number of stone: none.
Crayon number: 400; made thus:

Carnauba wax	330 grains
Castile soap	770 grains
Lampblack	120 grains

Proofs pulled: 20.
Stone: immersed in water before the roll-up and etch.

As stated in the text, this is a possible procedure. I have made numbers of lithographs by its means. But I could not recommend anyone to depend on it until he had become a thorough expert by some years of practice.

it is the drawing which prints. And I find nowhere any discussion of the effect of the etch on the printing quality of the drawing. The idea, very natural and widely held, that what etching does, and all it does, is in the direction of injury to the drawing, I consider erroneous. My experience shows that before the injurious stage is reached there is a stage at which the effect is actually to enrich the work. Extreme cobwebs—very easily etched out of existence—if etched just enough, actually roll up stronger than when not etched at all.

Fully and exactly what happens when we etch a stone nobody seems to know, but what seems to me to happen is something like this: The stone has responded to the acid by a certain degree of dissolution: in effect it melts a little, and its lime, the gum, and the greasy material of the drawing get mixed up with each other in a mixture that is partly chemical and partly mechanical. We dry this mixture, then we wash the stone, and what happens is that all that is not in a fixed combination, chemical or mechanical, with the stone is removed. The thickness of the layer remaining, composed of these several elements, is greater in proportion as the acid has dissolved the stone to greater depth. But as the acid goes deeper into the stone, lowering the bottom of this film, the top of it soon reaches a point where its combination with insoluble elements is so slight that when we wash the stone we wash it away. This is how very delicate crayonings that have little substance in themselves, and but the slightest attachment to the stone, get etched out of existence.

Moreover, this conception enables us to understand the curious double action of the etch to which I have already referred—how a little of it makes the ink go down more readily than none of it, while more of it makes the ink go down less readily than a little of it. Stone mixed with gum is the very thing ink will not stick to; it is then only on the presence of elements introduced in the drawing, fatty matters, that we can depend to hold ink. If this is even *diluted* with dissolved stone and gum, the resultant combination, whether physical or chemical, or both, takes the ink less readily than it does if not so diluted. The etch, by dissolving the stone, favors a combination, which of course is also a dilution, between it and the ink-attracting elements. The greater the etch, the greater the dilution. This explains why an overetched stone takes the ink more feebly and why the ink it does take must be pressed on it with much greater pressure.

It may be thought that all these refined considerations have little importance in ordinary work, and indeed it is true that any amount of "ordinary" work can be rattled through on general principles. But my business has not lain with ordinary impressions but with extraordinary ones, and I have found that to get them is not possible without very intimate considerations. It is precisely in their mastery that the difference lies between first-class and commonplace work.

TO LEARN HOW TO ETCH PERFECTLY AND CERTAINLY

Proceed thus: Get a bottle of chemically pure nitric acid of analyzed strength. Put an ounce of gum solution into a druggist's graduate. With a medicine dropper, put counted drops of acid into the gum until, when stirred well and tested on crayon lines that have been rolled up and protected, you find it eats off very delicate work. You now have an etch with but one fault, it is too strong. Reduce the strength until you find the point at which it does not harm the most delicate work. Keep written records of every move. Your etch is now as strong as it can be. Your next step is to find how weak it can be. This is a more demanding operation, for the only ultimate test of over-weakness is its inability to keep the stone clean till the last of the edition. Moreover, an edition printed just to test the etch may easily mislead an amateur, since other things than weak etching may cause a stone to smut or clog up.

Commercial printers learn to know the strength of their etch by tasting of it. About like lemon juice, they say. Also, it can be guessed as being about right when it gives a gentle frothing on the stone. But these men are doing it all their lives. Even so, I rarely see in the work turned out by the commercial houses anything to convince me that their methods could deal with the problems we artists have, and which the method I teach you will enable you to solve.

In theory, there is a sufficient difference between one stone and another to make it necessary to make a special etch for every stone. Practically, this hardly amounts to much, provided we are always dealing with good gray stones. They do not differ enough to make their differences felt. Yellow stones I never use: they are unsuited to fine work.

I direct you to use nitric acid, as almost everybody does and as sometimes I do. But my more usual acid is a combination of this with muriatic. I

doubt there being any advantage in it, but having got started with it, I go on. The formula[1] is:

3 ounces, 65 per cent nitric acid, C.P.
10 ounces, 33 per cent muriatic acid, C.P.
13 ounces, distilled water.

With this mixed acid, when I had gone not once but many times through the testing experiments I have set you, I arrived at a formula containing in the heaviest etch 70 drops of acid to one measured ounce of liquid gum; in the weakest etch, 20 drops to the same gum. This heavy etch is either for work which is very dark and coarse or else work in which the ingredients of the crayon especially indicate a heavy etch. For limited editions of ordinary work 50 or 55 drops is enough. Delicate work I sometimes cut down to 45 or even 40. Mere dreams and cobwebs I have etched with as low as 30 drops, but used supplemental treatments, in printing, to keep the stone clean.

I control the quantity by using 1 dram to each 32 square inches of stone. I keep records of everything; and when my notebook shows an entry "etched 38–1," it means that the proportion of gum to acid was the same as when 38 drops of acid are put with 1 ounce of gum.

Elements tending to introduce erratic variations are the fact that medicine droppers are not standardized, each dropper delivering a drop of a size peculiar to itself, and the fact that the size of a drop varies according to the liquid it is made of. Acid and water, for instance, differ so much in their specific gravity, that, dropped with the same dropper, a hundred drops of one is considerably more in bulk than a hundred of the other. In addition to all this, tests have proved to me that, with the same liquid from the same dropper, the bulk of a hundred drops will be greater when they are dropped rapidly than when they are dropped slowly.

Latterly I seem to have escaped most of these troubles by substituting for counted drops measured "minims." According to the dictionary, a minim is "generally regarded" as "about" equal to one drop. The fact is that as a bulk measure the word "drop" has no exact meaning at all, whereas "minim" has. It is the sixtieth part of a fluid dram. Moreover, at the drugstore of Eimer & Amend (corner of Eighteenth Street and Third Avenue, New York City) you can buy a glass tube, with rubber suction bulb on the end,

[1] Sold by Eimer & Amend, corner of Eighteenth Street and Third Avenue, New York City, under the name "Bolton Brown's Lithographic Etch."

which carries a marked scale of minims just as a thermometer does of degrees. With this you can take from your acid bottle and squirt into the gum a definite number of minims, of the same bulk always.

Testing this instrument against the drop system, I found that, of the acid I use, a given bulk is expressed in numbers that are as two is to three, according to whether I say "minims" or "drops." From habit I still use the drops in calculating, but when I have determined the number of drops desired, I simply cut off one-third, call the remainder minims, measure them in the glass scale, and go ahead.

With a strangle-hold like this on the situation, I etch with complete confidence whatever comes, whether my own work or that of another. Moreover, it enables me to draw with a clear foresight of exactly the etch I shall use, number of impressions intended, etc. The heavy work is easy—it is the cobweb tones that test the printer.

One of my nudes was modeled hardly at all beyond an extremely slight passing of the thumb along the outer parts of the silhouette; yet by knowing both this and the acid accurately, and in advance, I etched it to perfection, pulling from it thirty dreamy proofs.

Aside from etching with gum-acid, etching may be done with acid and water. The gum method is now by far the most usual, though in old times the finest of work was regularly accomplished by flooding the inclined stone with a bath of acid and water, followed, after drying, with gum. Vincent Brooks gives this as his preferred operation. (*Encyclopaedia Britannica,* 11th ed.)

In the instructions I gave for etching, you were instructed to etch upon the rolled-up drawing; but of course if you prefer to experiment in that direction, you may etch direct upon the crayon. In such a case, a milder etch must be used, for a thoroughly rolled and resined work will resist an acid that will injure one not so protected.

It is possible to begin by washing the crayon drawing off with water, rolling up, and etching upon printer's ink. (See "My Personal Usage," p. 64.)

Also, it is possible to put gum on a drawing, rub it down to a thin coat with a dry cloth, dry it, wash the drawing out with anything that will dissolve it, apply a solution of asphaltum, wipe to a thin coat with a dry cloth, and dry. Wash all off with water, roll up, and etch on ink over asphaltum.

The foregoing was written two years ago. Today I find my preferred

procedure in etching to be different from any of these. I coat the finished drawing with gum. This gum I reduce to a very thin coat by one of two methods. I either wipe down the gum with a dry cloth or I scrape the stone with a rubber squeegee such as window-cleaners use. In either case, the gum remaining on the stone is but a very thin film which dries almost instantly. I now apply solvent naphtha or turpentine, and with a rag free from moisture wash out the design. I then apply a solution of asphaltum—the stuff sold as "asphaltum varnish" works perfectly—rubbing it out swiftly into a smooth, even, transparent, thin coat. This being dried, I apply a little gum-water and roll. The design comes clear. I sluice the stone thoroughly; then dry, resin, and etch.

It is the common theory that the darks of some designs will bear, and even demand, more etching than the lights. One way to do this is to etch the whole sufficiently for the lights, then paint out the sufficiently etched parts with gum and dry it. A second etch will now be largely held off the lights by the gum, while acting promptly and fully on the darks. Another way is to use the etch with a brush, painting it on thickest and longest where the most action is desired. I sometimes accomplish localized etching by first applying a gum coat over all and then working the etch into the wet gum here and there as I need it, with a brush. This avoids any sharp division between the differently etched parts. Practically, I hardly ever use a differentiated etching. With the strength of the acid exactly right, the faintest tints will remain, and also the darkest will be sufficiently etched.

Also, when all has been etched alike, the acceptance of ink from the roller will be everywhere the same. This will not be the case when different parts of the stone have been subjected to etches of differing strength.

I reflect here that perhaps one of the reasons why I am able to include in one etch both very faint and very strong work is my practice of washing out the crayon before the etch. The only reason I can think of why dark work should require more etching than light would be that the extra etch was needed to neutralize the extra soap. In the absence of soap—and my stones, as previously explained, carry no soap at the time of etching—a flat, even etch would seem reasonable; and practically, this is just what I find to work perfectly.

TO GET LARGE EDITIONS

To get as many prints as possible, etch strongly and keep the stone in very clean and perfect condition as you print.

The commercial world knows of a method to increase the number of prints, thus: A drawing is dusted with resin; a plumber's torch is quickly passed over it; the resin melts into the drawing, which is enabled to withstand an unusually fierce etch. This is known as the Eberle System. An improvement on it is claimed to be the spreading over the resined drawing a newspaper wetted with gasoline, the fumes of the gasoline melting the resin.

Senefelder, speaking of etching, says all "depends on etching as little as possible." Sir Hubert Herkomer, whose results lend force to his remarks, says, "It is better to etch too much than too little." As for me, I aim to etch exactly enough.

MY PERSONAL USAGE IN GETTING A STONE READY TO PRINT (IN 1921)

Every drawing varies, of course; but assume an ordinary design drawn on gray stone with Korn's crayon, from which I desire to pull prints neither lighter nor darker, but just as it looks.

I will probably apply a layer of gum, working some water into it immediately with my hand. When thinned and evenly distributed, I pour on a little solvent naphtha, or turpentine, perhaps carrying a little kerosene or linseed oil—at the same time charging a dry woolen rag with the same.

With the rag I sop the crayon entirely off, then sluice the stone with much clean water, washing it finally with a clean cloth or sponge and water. I invented and domesticated this heresy.

The roller being now passed, the design reappears, not doubtfully and with pain, but firmly and willingly. I do not overload it, but work on a water film that grows constantly thinner by evaporation. The tendency is for the stone to roll rather lighter as it gets dryer, the stopping-point being a question of judgment.

I fan the stone dry, dust on pulverized gum mastic, using my hand, brush off excess with a wad of cotton, apply talcum powder (French chalk) similarly, and am then ready to etch.

To as many drams of gum as there are units of 32 square inches in the stone, I add my acid in the proportion of 48 drops per liquid ounce. That is to say, if the stone has 224 square inches, I pour into my graduate 7 drams of gum ($224 \div 32 = 7$), to this adding 42 drops (from the dropper or else 28 minims by measure) of acid ($48 \div 8 = 6$; $6 \times 7 = 42$). This is well stirred. It is made fresh each time.

With brush or finger, I apply a trifle along the edges and over the borders of the stone. If these need cleaning, I here grind them off with pumice, then give a similar quick thin coat of the etch all over the design. The mass of the etch still is held in the graduate. If stray specks exist or I desire to add lights, I quickly, through the wet film, cut or scrape them out. The stone is now as it is supposed to print.

I throw on the main body of the etch, instantly distributing it with a thin, flat, soft brush, several inches wide. A thick brush drinks up too much of the etch, and I am apt to discourage even a thin one from doing this by wetting it a little to begin with. I brush the fluid about, sometimes favoring the design, until it no longer tastes sour; push the excess off the stone; and let it dry.

It may be printed at any time after a few hours, but is safer if a few days are allowed.

REMARKS ON THE FOREGOING

In the personal method just described, the total removal of the crayon by solvents before the roll is a contradiction to the attitude and practice of everybody—from Senefelder downward. Whether they knew much or knew little, all hands have agreed on the sacred necessity of preserving the crayon, and with most anxious care. The whole literature of the subject is eloquent of this anxiety. Nowhere can you find any hint, suggestion, or suspicion that the crayon is in fact totally superfluous the moment the artist has finished his drawing.

This was so incredible to me that it was only after exhaustive experiments devoted exactly to this question, and entirely decisive of it, that I gave up the whole traditional idea and adjusted my practice to the facts. It still seems, even to me, amazing that such work as some of my ethereally delicate portraits (printed in red)[2] could be got by first clearing the stone of every trace of the drawing by means of a powerful solvent and coarse woolen rag—yet that is the way they were made.

I do not ask or tell anyone else to work in this way. I merely report that I do. And I do it because I do not know another way so good.

[2] Metropolitan Museum, "Marian."

THE NEW PROCESS IN CRAYONSTONE

Moreover, in lithography there is no possibility of the printer's assisting the drawing with "retroussage," or spreading of the ink, as is frequently done in etching.

—T. R. Way, *Memories of Whistler,* p. 6.

I have had the pleasure of making the effects above referred to not only possible but actual, in lithography. Moreover, they are technically more in harmony with the crayon drawing than an oil tint is with the etched line. The result is more nearly all one thing. Prints of mine illustrating this method are in the British Museum and in the New York Public Library. They were first shown in public at the Knoedler Galleries, 556 Fifth Avenue, in October, 1922.

A drawing having been made on stone with a view to subsequent enrichment, as an etcher's design is made subject to future etching and manipulation in printing, I can get this enrichment by causing the fatty acids to spread. I do it by turning the gum from an acid to a neutral or alkaline substance by the addition of ammonia or lye.

The enrichment is in proportion to the amount of active fatty acids dissolved out and permitted to combine with the lime of the stone. And the amount of dissolution, as well as the degree to which it is permitted to unite with the stone, is controlled by the nature of the substances applied to it.

Beginning with the simple device of a little ammonia in the gum, I have explored along step by step until after testing more than a hundred stones I arrived at something giving effects never before got. By no methods hitherto known were they possible.

This something is, as above mentioned, the control of the dissolution of the soap, the control of the amount of its spread, and the control of the density of the roll-up by which the appearance of the print is determined.

In the end, by the slow but sure process of trial and elimination, I cornered, captured, and more or less tamed the substances that enable these controls to be accomplished. I established a fairly definite technique and by it brought into existence a series of prints.

The coating applied to the drawing must and does soften the crayon, and at the same time controls both the intensity of its attack on the stone and the area over which the attack takes place. I could write a book of adventures about my search for this substance. Many things hinted at being it,

THE PICNIC

Size: 8¾ × 9½ inches.

Serial number of stone: 430.

Crayon number: 400; made thus:

Carnauba wax	330 grains
Castile soap	770 grains
Lampblack	120 grains

Procedure: Instead of the usual pre-etch gum, I applied a liquid bath composed as follows:

Water	69 drams
Saturated solution of sugar	8 drams
Dry starch	12 drams
Babbitt's Concentrated Lye (saturated solution)	6 drops

This bath was confined by a wall,—the stone gently rocked, to get evenness of action. The starch settles on the stone in a layer which keeps the dissolved soap of the crayon properly localized. In the roll-up the amount of ink on the roller is less than usual; also it is much softer, probably made so, in this case, by heavy naphtha.

Size: 4½ × 6½ inches.
Serial number of stone: 420.
Crayon number: 200: made thus:

Carmine lake	330 grains
Caustic soap	770 grains
Lamphlack	110 grains

Procedure: Imposed of the usual pre-arch grain, I applied a liquid bath composed as follows:

Water	60 drams
Saturated solution of sugar	8 drams
Dry starch	12 drams
Rabbit's Concentrated Lye (saturated solution)	6 drops

This bath was continued by a wash—the stone gently rocked, to get evenness of action. The starch starts quickly alone in a layer which keeps the dissolved soap of the crayon properly localized. In the roll-up the amount of ink on the roller is less than usual: also it is much softer, probably made so, in this case, by heavy naphtha.

but the thing that at last really was it is simply a saturated solution of granulated sugar. Honey or glucose I have not yet tried.

Needless to say, the degree of solubility of any crayon must be met by exactly its special control substance. This sugar solution—the "s.s.s." of my notebooks—was worked paired with my crayon No. 404.

Having drawn with this, I lay the stone on the graining stand and make around its border a wall of strips of wet blotting-paper (clay might serve). A wall as high as four thicknesses of this suffices. This converts the surface of the stone into the bottom of a reservoir. Over this I throw a suitable quantity of s.s.s. It must go on suddenly, all over, and then lie still. I add, by driblets, water, all over it, till its consistency is considerably reduced. To the eye, the black crayon appears to be doing all sorts of things, but this means little because it is not the carbon of the lampblack but the invisible soap that is really doing the work.

When ready, I suddenly remove the walls, sluice extensively with water, and with a previously and very carefully compounded ink, begin to roll. For a time, not much happens; but at last slowly, evenly, and most beautifully, the image begins to come. As it develops, and it is a true case of development, by the manipulation of the roller in my hands I can and do exercise artistic judgment and control over its creation and character.

Neither in Senefelder or any subsequent writer is there a hint of any such conception. No lithographs ever done have anything like the same qualities as those by this process.

IX. THE PRESS

THE TYMPAN

IN SENEFELDER'S day, the tympan was made of leather, as, in fact, it still is sometimes. However, I found zinc tympans in use in England. On complaining of one of these latter on my own press, I was advised that brass was better, and better yet was copper "because of its more malleable nature." So I procured and long used, with satisfaction, a tympan of 23-gauge sheet copper. Returning from London to this country, I found the metal tympan largely abandoned in favor of a sheet of very hard pasteboard, named "press board." A brief experience convinced me of its marked superiority, since which I use nothing else. This "red press board" comes in a number of thicknesses. I long used No. 125. It worked well, but was thin enough to yield a little elasticity in its own plane, and hence occasionally a long wrinkle or pleat would form itself as the tympan slid under the scraper. This, on subsequent prints, would yield greater pressure where the board was doubled, along the wrinkle, and this would give dark streaks in the print. The secret of avoiding this mishap is to keep the stone free from being ground hollow, keep the backing papers and backing board of equal thickness throughout, keep the lubrication on the tympan's back as full at the edges as it is in the middle, and keep the scraper from pressing harder at its ends than in the middle. Backing papers sometimes get a lot of repeated squeezings in the middle, and, becoming slightly thinner thereby, tend to ease the pressure as compared with that at the edge, thus encouraging the formation of such a wrinkle in the tympan as I have described.

Of course, the thicker and stiffer the red press board is, the less it tends to wrinkle under the above-described stresses. I have, therefore, substituted a considerably heavier grade, No. 200. This works well just as it is, but I have markedly reduced the labor on the handle of the press by first treating it as follows: I cut it to size, rounding the corners for convenience, and lay it on a pad made of three or four flat sheets of blotting-paper. I sprinkle over it a little carnauba wax, and with a common flatiron heated to about

the temperature of boiling water, I melt this in and smooth the surface. This I do quite thoroughly. I then turn it over and coat the other side with wax in the same way. This doubling the facing of wax has two merits: it adds to its stiffness, and it makes the under surface, which sometimes gets a slop of water, waterproof. When the wax has solidified, preferably while still warm, I take a table knife or other suitable instrument and scrape off any excess, eliminating all bumps and ridges, moving the knife parallel to the direction the press scraper will run in. I then rub it with a harsh cloth, used in the same direction, till it takes a high polish. This completes its preparation.

Tallow is an acceptable and excellent lubricant for the back of the tympan, and is in universal use. I have experimented with a wide variety of substitutes. For the tympan of red press board prepared as above described, I have found by far the best lubricant to be butter. I melt half a pound of butter and when it is very hot decant the clear top part from the sediment. This, just as it is, makes an ideal tympan lubricant at cool temperatures. When the weather is warm, I add to it whatever amount is needed of lanoline—sometimes up to a half.

By preparing and lubricating the tympan in this way, I reduced the labor of turning the handle of the press at least 50 per cent over my best previous arrangement. And that makes a very acceptable saving in a day's work.

BACKING PAPER

In the early days, expert printers of fine lithographs put behind the printing paper two sheets of plate paper, a piece of cardboard, and then the tympan. Be it said here, that the more perfectly true are the stone, the scraper, and the leather, the less of this elastic packing behind the print is necessary. I have made many excellent prints with merely a single sheet of blotting-paper acting in place of both plate paper and cardboard. However, I oftener retain the cardboard, using in front of it, in preference to plate paper, a single blotter. This supposes, in front of the blotter, some sort of soft backing paper to which the damp print will stick, either temporarily or permanently. A good way to get prints flat is to put print and backing paper, without pulling them apart, between dry blotters and weight the pile. When perfectly dry, the prints may be peeled off the backing pieces and will be found fairly flat. Just how flat, and just how long they will remain flat,

varies with different papers. The way to peel a print off is to lay its face to the table and, holding it flat, peel the backing off of it. Some backing boards that have little or no size, used with papers also devoid of size, will not adhere to the print with any reliability. These can be pulled off and dried independently. If a print, just pulled or partly dried, is partly adherent to its backing and partly free from it, do not dry it in that condition—it will form permanent wrinkles—but remove it completely. The backing sheet that goes next the print may be a heavy plate paper, a soft cardboard, or a piece of blotting-paper. Each will work well. I remember once pulling a fine edition using as backing several thicknesses of the rotogravure section of the Sunday paper.

The simplest and surest suggestion I could offer a beginner would be to lay in a supply of white porcelain blotting-paper. The "porcelain" finish is rather a luxury, as ordinary blotting paper also works perfectly. Thus, with blotting-paper adopted as backing paper for both elasticity and for adhering to the damp print, no other backing is necessary. Even the cardboard may be omitted, though I generally retain it.

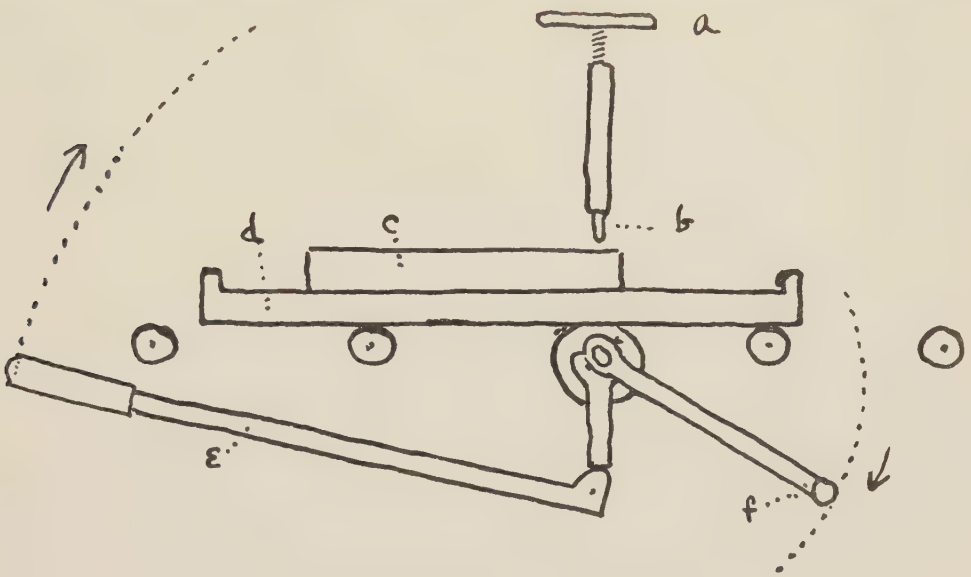
STARTING THE PRESS

The press is designed to carry, set edgewise in the slot in the iron part of the scraper, a wooden board narrowed at its lower edge. (The cut shows a section of this.) Strips of boxwood or maple having this section are on the market. You saw off a piece longer than the width of your design and shorter than the width of the stone. You buy also long straps of scraper leather. Cut a piece of this some inches longer than your wooden scraper and put it in water. When it is soaked, take a large carpet tack and tack one end to the sawed-off end of the scraper. Seize the other end with pincers, draw it strongly along the face of the scraper, and tack, in its stretched condition, to the other end. It will dry flat and tight. Then grease it well and insert it in the press.

Upon the traveling table of the press it is well to place something which, when the stone is laid upon it, will give a trace of elasticity to what is otherwise a pretty rigid situation. The lithographic supply houses furnish a mat of rubber for the purpose. A wooden grating has been recommended. At the present time my own press is equipped with four pieces of sheet rubber, made to be used on the tread of stairs, bought at the ten-cent store.

Wet a clean cloth or sponge and wash the gum off the stone. Roll up. Lay on your design a sheet of damp printing paper, over this your backing paper, then your six-ply cardboard, and finally the tympan with its well-lubricated back. Push the table along until the edge of the stone has passed about an inch under the scraper. Now mark on the frame of the press, with chalk, where the end of the traveling table is. This mark enables you to bring the stone to this same position next time.

By means of its controlling screw the scraper is now lowered till it is stopped by coming against the stone. Throw back the lever. This drops the



CROSS SECTION OF A LITHOGRAPHIC PRESS

(*a*) controlling screw; (*b*) scraper; (*c*) stone; (*d*) table; (*e*) lever; (*f*) handle

stone and allows you to turn the screw of the scraper perhaps a half a revolution or perhaps a whole one more. Try to see if the lever will now go down without undue forcing. It is well distinctly *not* to force the pressure just at starting. When the pressure is right, throw the lever completely down. With a swift, even motion and without stopping, turn the handle of the press until the scraper comes within about an inch of the other end of the stone. Throw up the lever. Roll back the table, lift off tympan and backing and, without using force, delicately lift or pull the print from the stone.

Immediately, without pausing to get lost in an examination of the proof, re-wet the stone. Get the habit—attend to the stone first and the im-

pression afterward. The stone is not supposed ever to get really dry at all, unless when gummed. If you go across the road to get a drink, put gummy water on the stone. I have a sheet of pure rubber which, smoothed out upon a sopping wet stone, keeps it wet.

If the print just pulled was not from a freshly washed-out stone, the first and several subsequent prints will be worthless, since it is not really printing that is now taking place, but a cleaning of the old ink off the stone by going through the moves of printing. Real proofs may begin to come at any place between the third and the fifteenth print; generally four or five suffice me. If you start from a newly washed-out stone, the second pull will generally be perfect, quite often the first. If the proofs seem gray, try a little harder pressure. If they are gray still, do not try to darken them by terrific pressure; seek for the cause elsewhere, in the ink, the paper, or the damping.

Richmond, author of the authoritative textbook on lithography, *Grammar of Lithography,* lays down the sound rule to print with a minimum of ink, of pressure, and of paper dampness.

It is my habit and preference to pull an edition straight through, without stopping. Almost any interference with the rhythm of the proceedings is liable to cause a change and easily causes the loss of a print or two. The great thing is to pull while the pulling is good.

ADDED WORK AFTER PRINTING HAS BEGUN

Correction of crayon work, after it has been etched and used for printing, is especially difficult.

—Senefelder

If, at any time after the stone is etched, additional work is to be done, sponge the place where this is to go with a weak counteretch of acetic or citric acid. This dissolves away the gum preparation and allows the crayon to come into chemically intimate contact with the original stone. The new work must of course be etched, gummed, and dried.

The counteretch solution should taste about like lemon juice and when applied to the stone should not be strong enough to effervesce. It should remain on the work about a minute and then be washed off very thoroughly.

This little island of newly added work is surrounded with other work already sufficiently etched, and it is the difficulty of avoiding overetching

the adjacent parts, when the new work is etched, that limits the value of this process. A small grinder used with a dry abrasive will grind out a passage which, brushed clean, may be redrawn.

TO DARKEN THE TONE OF A PASSAGE WHILE PRINTING

They say professional commercial printers apply ink diluted with turpentine; but, except in the coarsest of work, I should hate to rely on such an expedient. Palm-oil also will darken a passage, though I find this tends toward smutty proofs, palm-oil having a peculiarly fierce affinity for the stone. Obviously, all such schemes are things to be handled with gloves, metaphorically speaking, especially by amateurs.

You cannot get perfect but light proofs by lightening the pressure on the scraper. If a proof is light from this cause, some of the detail is left out. Neither can you get darker prints by excessive pressure.

X. THE TRANSFER

TRANSFER AND CRAYONSTONE COMPARED

IN READING technical writing the layman's best chance to keep straight is to read with extreme care. One reviewer of my essay, *Lithography* (published in 1923 by Fitzroy Carrington), depicts me as a doctrinaire, propagandizing my prejudices and personal opinions, because I pointed out physical facts offensive to him. The literary person has difficulty in distinguishing fact from opinion. A technical person, who is not a fakir pure and simple, does not deal in opinions at all. His mind is stored with direct, personal, sensuous experiences of physical substances. His expression of this, if words mean anything, is not opinion, it is knowledge. Whatever I have to say, of a technical nature, is of this matter-of-fact sort; and all of my personal self that I have projected into the field is one new word.

By introducing the word "crayonstone," we classify lithographs according to what they are drawn on instead of what they are printed from. Aesthetically, the printing surface is of no particular importance, but the drawing surface is of the very greatest because according to its qualities your drawing possibilities are limited absolutely.

I am not recommending one or the other of these methods to this or that artist—I am merely pointing out physical facts. I will make a somewhat fuller comparison between the two. Every work of art demands of its creator a definite tax in time and labor, and this tax is in some ways less when you work on paper than when you work on stone. You can move your paper around more easily; and if matters go wrong, you can throw the whole thing away at the loss of only a sheet of paper. Whereas, if a drawing fails on stone, you lose the labor of grinding it. There is also, with transfer, the advantage that the print does not reverse the drawing as crayonstone does.

Real advantages these are, yet they are not at all serious ones. They concern but the momentary convenience of the artist, leaving practically untouched the question of the results he gets; whereas crayonstone's advantages are all in the matter of results.

From the remotest times artists have had a way of searching and choosing among tools and processes for something better. And what they have in mind as better is not a thing of greater momentary convenience but one that will carry more of themselves, or, if you prefer, more of nature. It is all one, because a man is only the totality of his reactions to nature and nature is to him but the same thing, so that whichever way you choose to say it, art is simply—expression.

Expression varies in degree, those variations pertinent to this discussion being imposed by the character of the substances used. By painting on the side of a barn with a broom dipped in a mud puddle you can express something; but with tools we rightly call "better," you can express more, and they *are* better *because* they can express more.

In nature we have an infinity of light and dark, but in art only paper and ink. Here is a limitation involving the whole world of solid forms so far as modeling goes, and the whole world of flat forms so far as they show by differences in value. The limitation, a purely physical and technical one, is enormous. We are almost as greatly restricted in the matter of defining edges, for not one of our materials can draw an edge anywhere near the fineness of millions that we see. We recognize in these things why artists naturally keep experimenting around for something better, something that pushes back these restrictions and reduces these exclusions.

The best drawing materials, so far as solid form goes, are those of greatest range of value, and the best definition of "edge" is that which can draw both the sharpest and the softest lines according to the occasion.

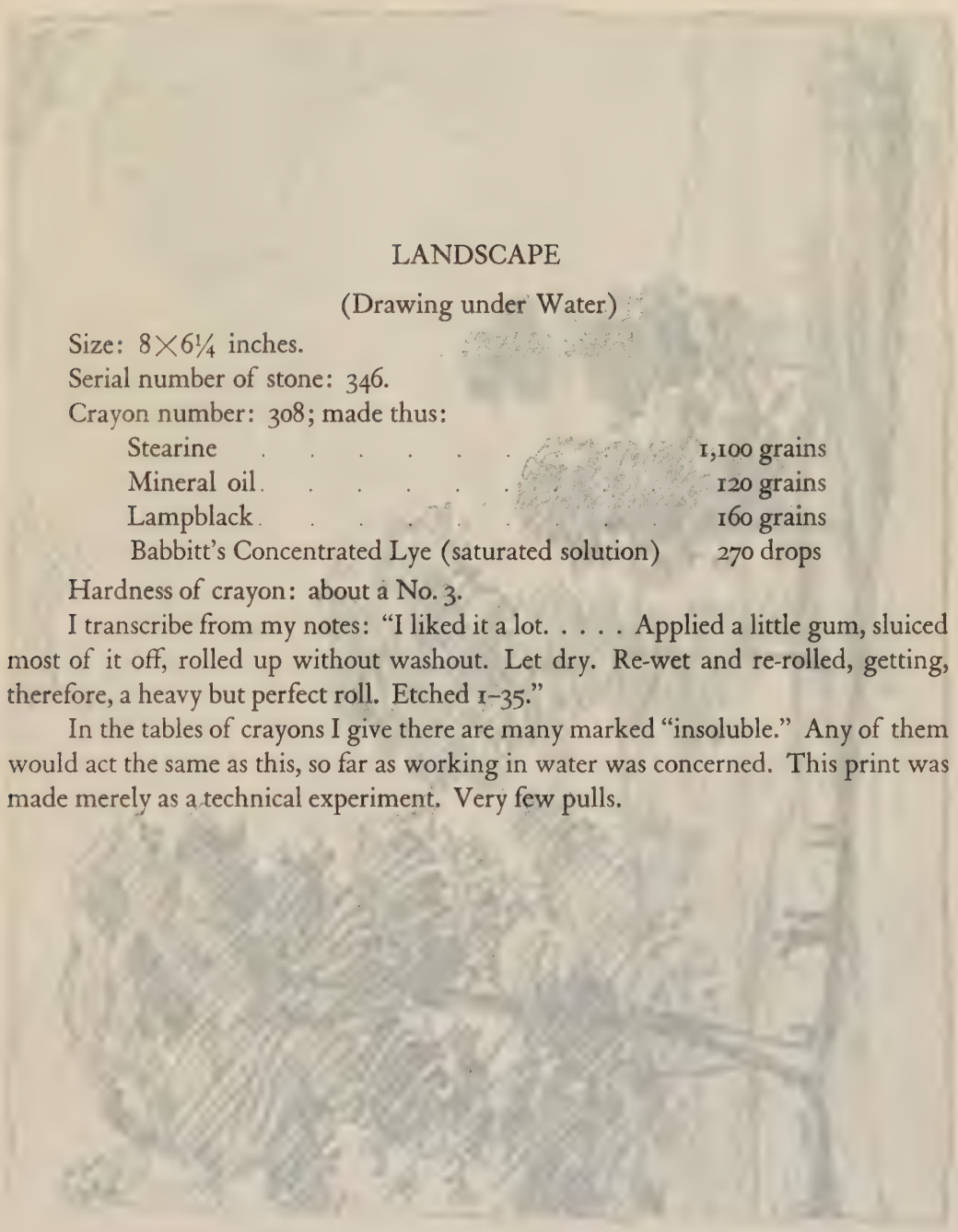
This brings us round again to consider how crayonstone and transfer compare in expressional power. In transfer, the limitations of definition are those of crayon on paper. These are greater than those of crayon on stone. Three causes contribute to make this true—the stone is flatter, harder, and more finely surfaced than paper. It resists the pressure of the point better; and, last, the act of transferring subjects paper drawings to injuries not present in drawings made on the stone direct.

In the matter of the limitation of gradation, on which all modeling depends, stone is the superior article again because it is harder, flatter, and more firmly surfaced, and because the drawing is not subjected to the strain of being transferred. Owing to its physical qualities, it is almost impossible to make lithographic crayon yield on paper fine textures, and those you can make fall off in quality in the print. They lack the beautiful transparency

of stone work and become woolly, opaque, and unreliable. And if the unreliableness shifts values only a little, that may be enough for aesthetic destruction. The reader will begin to see why we do not find delicate tonality in transfers. Intelligent users of it do not attempt it; others attempt it and fail.

However, these matters of definition and gradation are not of equal importance on all occasions. They vary as the dimensions of the work vary. The smaller the work, the greater the advantage of stone over paper. In work of poster size, they are more nearly equal than in portfolio size; and, as we go on down, the restrictions imposed on transfer increase far more rapidly than do those of crayonstone. Two artists, Fantin-Latour and Whistler, who thought in terms of tone, tried to express their thoughts in transfer. But neither in these cases nor any other has even genius itself been able to overcome what Hamerton calls the "ineluctable conditions of matter." To get merely the vague tonality which was his usual aim, Fantin-Latour was forced to supplement transfer by crayoning and engraving—extensively—the stone after the paper drawing had been put down on it. And the transfer from Whistler's sketches on paper (made by H. P. Bray, in Thomas R. Way's printing establishment) either show a very summary tonality indeed, or else what there is has also been got by working the stone after the transfer had been made. Mr. Pennell's lithographs also are transfers, and they succeed better than most precisely because they remain frankly within the limits of transfer as just described. They are summary in intention, with little or no modeling, and either large in size, or, if small, correspondingly simplified. Certainly, even thus limited, you can do excellent things. Mr. Pennell has done them. But you can greatly increase your range by substituting stone for paper. Whistler, who practiced transfer, left written and published testimony that he found it "restricted indeed."

Consider, too, how in the past crayonstone has been used in competition with the finest engraving, to reproduce whole galleries of fine paintings, and imagine the result if anyone were to try anything like that with transfer. Also, recall how scientific people, who are very keen about expression of the things they want expressed, have always used crayonstone lithography and never transfer. This is the more significant in that drawing on paper would always be both cheaper and easier.



LANDSCAPE

(Drawing under Water)

Size: 8×6¼ inches.

Serial number of stone: 346.

Crayon number: 308; made thus:

Stearine	1,100 grains
Mineral oil	120 grains
Lampblack	160 grains
Babbitt's Concentrated Lye (saturated solution)	270 drops

Hardness of crayon: about a No. 3.

I transcribe from my notes: "I liked it a lot. . . . . Applied a little gum, sluiced most of it off, rolled up without washout. Let dry. Re-wet and re-rolled, getting, therefore, a heavy but perfect roll. Etched 1–35."

In the tables of crayons I give there are many marked "insoluble." Any of them would act the same as this, so far as working in water was concerned. This print was made merely as a technical experiment. Very few pulls.

TRANSFERRING

To the professional commercial lithographer, the word "transfer" suggests the transferring of prints. The kind of transferring that chiefly concerns artists, however, is that which consists in transferring a drawing made on paper; this, therefore, is what I shall speak of.

Commercial drawing intended to be transferred is done on paper surfaced with a soluble coat, which coat, after the work has passed through the press, is softened by water so that the paper peels off the stone, leaving the drawing adhering to it. Such surfaced paper is not generally liked by artists to draw on and, in fact, it has been found that many kinds of uncoated papers can be made to transfer about as well as coated paper does.

Quite an array of methods for making the crayon come off the paper and stick to the stone have been invented and used. Some persons heat the stone a little. This may be done in an oven, or by pouring hot water on it, or by burning alcohol on its surface. I have found the last-mentioned method convenient; I seldom use it, however, because I do not find it necessary to heat the stone at all. Some damp the stone with turpentine, and I have used this too, but gave it up as superfluous.

Different crayons require different treatment in transferring, as also, naturally, do drawings on different papers. The quantity and character of the sizing of the paper must be allowed for. A coarse-grained paper is a different article from a fine-grained one.

The fundamental essentials to success are two: you must press all the crayon of the drawing into firm contact with the stone, and yet you must not squeeze it hard enough to "squash" it. A rough paper, in order to bring its hollows into contact, must have strong pressure. But this again can be mitigated to almost any extent by damping, thus softening the paper. Still, such softening of the paper cannot be carried indefinitely far, because the crayon also is all the time getting damp, and so growing softer, and so increasing its tendency to squash.

It is usual to put drawings between damp blotters before transferring. To amuse myself I have, by using much pressure and a naturally soft paper to draw on, made good transfers without any damping whatever.

The freshness of the drawing affects the amount of damping necessary, because an old crayon drawing gets hard and damping softens it. The older it is the longer it needs to be damped. If only a few days old, very little

damping—so far as the crayon is concerned—is needed, though damping to soften the paper must be considered quite aside from this. A crayon drawing several months old is softened by being damped for an hour or two.

The more heavily sized the paper is the more it must be damped. The thicker it is, the longer it is damped. The stiffer the fibers, the longer the damping.

The less a paper is damped, the greater the pressure necessary to make a transfer from it. The harder the crayon, the greater the pressure. The coarser the texture, the harder the pressure.

When luck has been with me, I have succeeded in making perfect transfers from very old, dry, crayon drawings by softening the crayon with naphtha and the paper with water, simultaneously.

When the problem of getting the crayon into true contact with the stone has been solved, the next one is how to get the paper loose, for it will usually stick. A strong paper, allowed to dry first, may be peeled off by main force. Tender papers, when this is attempted, come off in flakes leaving bits stuck to the stone wherever there is much crayon. Sometimes I have got such papers off by covering them with a lake of thin gum-arabic solution and leaving it for a little while, the flakes of paper being then pulled off one by one, or scrubbed off with an artist's bristle brush. In the case of a very soft paper, this method removes it in the form of paper pulp, literally.

Though the crayon often leaves the paper for the stone, it does not do so necessarily. It may split itself, and you may find part on the stone and part on the original paper. The prints may be quite as good as when all the crayon comes off. In fact, under some circumstances so little crayon comes off the paper that not much of anything is visible on the stone. There has, however, been a contact, and a skilful roll-up will bring out an image which, properly treated, will print.

A successful transfer requires that the stone be perfectly flat, the scraper without any flaws, and the backing strictly uniform all over. These requirements will not bear slighting, for the least shortcoming in any of them is sure to appear, greatly magnified, in the print. And it cannot be changed then—the job is ruined, once for all.

Ferocious pressure is not commonly needed: I use ordinarily about the same that I print with. More backing, however, is desirable—say three or more blotters behind a sheet of well-flattened plate paper. The lubrication, too, must be good: it is very easy to mistake bad lubrication for heavy pressure.

A drawing may be transferred to a delicately grained stone or to an entirely smooth one. The old orthodox method required the stone to be actually polished. I find no advantage in this, and transfer on a stone surfaced with FFF carborundum powder.

Specially sensitive surfaces—chemically sensitive, I mean—can be put on to help get every trace of the drawing. Alum, bicarbonate of soda, whiting, etc., are recommended. I have made good transfers without any of these, simply using the clean bare stone.

Suppose the transfer has been made and the paper removed. The next step is, in ordinary cases, to put thin gum on the stone (sometimes containing a trace of sugar if a reluctant roll-up is foreseen) and let it remain a few seconds, then sluicing most of it off with water. Upon the wet stone (a trace of gum being still present) I gently and with ordinary or slightly soft ink roll up. Gradually the design takes the ink. In two or three minutes I have a perfect roll-up. In the course of getting it, if, owing to excess crayon or excessively soapy crayon, I have reason to fear an unnaturally heavy roll, I head this off with a douche of delicately acidulated water, stronger or weaker according to the way the thing is acting.

When the roll-up is complete, if it is a rich one and I desire delicate proofs, I sluice it with water, and then fan dry. If it is none too rich, or if I wish strong proofs, I do not douche with water, but fan as it is. Sometimes I take off water with a clean blotter. When dry, I dust with resin and chalk, etch, and let dry, exactly as for a drawing done on the stone.

If, as sometimes happens, when the roll-up is complete, faint halos are to be seen (even with a magnifying glass) creeping out from the lines, the stone should not be allowed to dry until this has been removed and does not recur. If a rolled drawing is sluiced with water long enough, this creeping film will at length cease. If sluicing is undesirable, redamp the stone and roll anew, continuing the rolling until the stone is so nearly dry that there is not enough moisture for the grease film to float out on; then instantly fan vigorously till dry. It will now print clean.

Senefelder suggests softening the crayon used for transferring by means of tallow. This is very poor advice, for the softer the crayon is the more likely it is to spread and give squashed work. It is quite unnecessary: I have again and again tested the whole battery of crayons, and the harder crayons transfer just as surely as, and more perfectly than, the very soft ones.

XI. PAPERS

PAPER AND ITS USE

PHYSICALLY, a sheet of paper is a feltlike mat of fibers. Under pressure, it is compressible. It takes water like a sponge. The surface is irregular and porous. Under a microscope, it is far from being a continuous surface. The theory of printing on it requires, however, that it be continuous, and the surface which is most nearly so will come nearest to receiving the ink as it was on the stone. For the foregoing reason, open-surfaced papers yield gray proofs.

The fibers of some papers, for reasons unknown to me, seem to attach themselves to the ink better than others do. One unsized rag paper I know pulls gray proofs: it is cotton fiber. Another of linen fiber does the same. A cheap, unsized, machine-made pulp paper that I know pulls marvelous impressions. Probably there is a little clay in it.

When dry, papers with appreciable amounts of sizing are impossible. When damped, the adhesiveness of the size may even help the ink hold, always provided that the dampness is just right. Or, it may be that a part of the effect observed is due to the merely mechanical function of stopping up the pores and so presenting a more continuous surface. If paper is not damp enough, the size acts as starch does in a collar, it stiffens it. In this condition the press is not able to force the surface into a complete contact with the stone. If paper is too damp, two ills follow: bits of oversoftened paper may pull out and stick to the design; and it may be so wet that the ink is kept from adhering to it by its wetness alone. The first evil yields prints with white specks in them; the second, prints that are gray and coarse.

If the dampness is quite right, the theory is that the paper is soft enough to be pressed into a complete contact, while remaining hard enough to hold together against the pull of the ink, and so nearly dry that under the pressure of the scraper, forcing the moisture up into the backing, it is, just at that moment, practically dry and therefore secures a good hold on the ink.

The wetter the paper, the softer the ink should be to keep from pulling the tender paper up in shreds.

The wetter the paper, the harder the pressure—to help squeeze it dry.

The stiffer the ink, the greater the pressure—to secure contact.

There are other things besides adhesion to consider. A sheet of paper is slightly elastic; if damp, much more than slightly. If still more damp, it is moving in the direction of being wet paper pulp: its fibers will shove about a little; under indirect pressure it will tend to squash out and to crawl. The thinnest papers have not bulk enough to make this effect appreciable, but as thickness increases, it becomes a menace. Naturally, even an infinitesimal crawl of the paper shows in an inferiority of impression. Protection against this is in greater dryness. A perfectly dry sheet, no matter how thick, never crawls.

If a very thin paper be damped a very, very little and laid on the stone and over it be placed an unsized (and therefore soft and elastic) paper, perfectly dry, and a print pulled, it will be a dream of loveliness. The method just described is that by which India proofs are pulled—a very perfect, thin, damp, surface-paper.

It is not necessary to have these particular papers, however, to get the benefit of the principle. Many ordinary bond, ledger, writing, and book papers, used as though they were India paper, will, even if backed by ordinary blotting-paper, perform like India and yield superb impressions. If such impressions are intended to remain permanently attached, as insets, to the backing paper, a trifle of weak paste may be used, applied at the edge. My custom is commonly to separate from its backing the thin paper that carries the impression, dry it, and deal with it by itself.

Ideally, the thinner the damp surface-paper that receives the print, the better. Also, the less dampness it carries—up to a point—the better. And the dryer the backing just behind it, the better. When printing a fine edition, I put a perfectly dry back to every impression.

The foregoing conception of printing practically divides the sheet of paper printed on into two layers—a thinner and more perfectly surfaced and delicately damped one; and a thicker, possibly coarser, unsized, elastic, dry, upper one. Discussing this matter with Ernest Jackson, I stated, "The thinner the paper the sharper the proof." "Yes," he replied, "that is true." Not a word to this effect is in any of the books.

THE DAMPING OF PAPER

Paper is damped either by absorption or immersion, with subsequent lying in stacks under heavy weights. In the first method, dry paper is interleaved with damp blotters: in the second, wet paper is interleaved with dry blotters. The second system is the more laborious, and for a long time I used it exclusively because its results seemed practically certain. Now, however, I work almost entirely by the first system, wherein a sheet starts dry and gets damper. In practice, the printer finds it harder to make a sheet that is a *little* too dry go backward and take up a little more moisture than he does to make a sheet that may be a little too wet go forward and acquire a little more dryness.

The addition of staining solutions to the water, when the immersion system is used, will tint the paper. Better results follow if the staining is done first in a separate tray, the sheet then rinsed in clean water, from which it goes to the dripping stack of wet sheets. This soaking pile, when complete, may be topped and bottomed with blotters and a board and then squeezed hard in a screw-press. From this, in a few minutes, it may be removed, and its sheets stacked up in alternation with dry blotters and the whole, subjected to severe pressure, left until printing time the next day. The edges of the blotters must be wetted: otherwise they dry the edges of the sheets in advance of their centers, the result being that the paper will not lie flat on the stone.

Nothing but experience—and new experience is required with each new paper—will enable one to damp paper exactly right. But without a mastery of this art no perfect proofs—to say nothing of whole editions—can be made.

The traditional device of the printing room, when the damp blotter system is used, is the affair called a "damp book." It consists of a number of sheets of damp blotters, or other absorbent paper, heavy enough to act as reservoirs to hold moisture. The covers of the book are, if orthodox, sheets of zinc. A substitute is found in squares of oilcloth or rubber cloth. Squares of damp cloth, by the way, have been used instead of paper to stack printing paper in. Carbolic acid will keep mildew out of the damp book.

MY PERSONAL PRACTICE IN DAMPING PAPER

Having measured the picture rectangle, I add to each dimension twice the amount of the width of the margin proposed for the print. This gives the size the paper is to be, and accordingly I cut or tear it so.

From this point on, every paper has to be handled differently. One thing I do with all papers, however, is to lay them face down and refrain from ever turning them over. While piling them face down, I sort out defective sheets, and remove specks, etc. The pile I then divide into subdivisions containing from one to ten sheets, according to the paper. In the case of, for instance, India paper, the divisions each carry six sheets.

Now I lay on the table a rubber cloth or sheet of zinc and place upon it a sheet of blotting-paper. This I dampen by dabbing it freely with a pretty wet sponge. I lay on it one six-sheet pile of India paper, then add another blotter, damp as before, again lay printing paper, and so continue until all is stowed away in this damp book. I wrap the book in oilcloth, put a drawing board on it, and either put it in a screw-press or weight it with stones. Generally, it remains thus until the next day. Two days is still better. There are a few papers which are so sized that under this treatment they become unduly corrugated. A good deal of corrugation may be ignored; but when the amount becomes too great, I head it off by laying each sheet upon clean zinc or glass and sponging both sides of it with water before putting it in the damp book. Handled thus, it does its swelling before it is squeezed, and comes forth for the printing beautifully flat.

AVAILABLE PAPERS

The kind of paper depends greatly upon the size and character of the drawing to be printed on it. Naturally, the coarser a drawing is, the less we shall notice additional coarseness added by printing it on a coarse paper. Whether the work is large or small, however, the actual texture the artist achieves is preserved most completely on those finer printing papers that have no tendency to inject a texture of their own. Some of my own prints make severe demands upon the paper in receiving and returning to the eye exactly what was on the stone, and have been the occasion of a deal of heart-breaking but illuminating experience. However, I am not proposing to go at all into that here, but merely to make a few large observations. You get your own experience of details yourself as you work along.

In general, paper manufactured to be printed on, in any way, will receive lithographs. More particularly this applies to papers known in the trade as "book" papers. Of these, the softer varieties are to be preferred.[1]

[1] To be had of Henry Lindenmeyr & Sons, 480 Canal Street, New York City.

A very fine paper, described on the label on the ream package in my studio as "A superfine printing paper" is watermarked "Basingwerk Parchment." It was made in England and imported for me by H. Reeve Angel & Company, 7 Spruce Street, New York City. I buy chiefly that which weighs 60 pounds to the ream.

Originally I went much into the question of all the handmade papers, and printed on countless kinds of them. None is now made in this country; but various importers, of whom I mention the Japan Paper Co., 109 East Thirty-first Street, New York City, bring it from European and oriental sources, and some of it is tempting. However, only a little of it is available for fine lithographs, even if we ignore the question of the high price. In a recent visit with Mr. Dard Hunter, who, I suppose, knows more about paper than all the rest of us put together, he told me, in effect, that the notion that handmade paper was nowadays more permanent than machine-made paper was more or less erroneous, and that machine papers were being made so well that they would last just as long as if they were made by hand. As there seems no reason to doubt this, I do not hesitate, when so minded for artistic purposes, to use, for instance, the Basingwerk Parchment previously mentioned. Some of it I have had around for seven or eight years, with but the faintest change of color, whereas even the best handmade Whatman's does darken, in time. I pulled many of Bellows' prints on this. He preferred it to all others.

Chinese papers, of which I have got several varieties from Chinese merchants either here in New York or in San Francisco, are all made by hand. These people ought to know how by this time, since it was they who originated the art, and they have been practicing it, according to some authorities, for about eighteen centuries. What they have furnished me with has taken good prints. I can recommend the regular "India" paper. (The wholesale lithographic supply houses import it, coat it with paste, and resell it as "transfer paper.") As it comes, uncoated, from China, it is the genuine article to which all our machine-paper manufacturers pay the compliment of extensive imitation and piracy of its name. They catalogue endless "India" papers, but really the only actual "India" is this I am speaking of, and it comes not from India but from China.[2] It comes in bundles, wrapped in

[2] Ringwalt's *American Encyclopedia of Printing* says: "India. . . . . These papers are made almost wholly of unbroken cells. . . . . From such material was made a real India paper which from its softness has been so much employed for proof impressions. In our times it is

joyful yellow decorations, weighing about 11 or 12 pounds each and containing about 94 sheets. The size is 29 by 52 inches; its color, a very pale and lovely fawn gray. Its defect is that it is apt to contain dirt, China being a windy land and this paper being made in open sheds. In cases where I have wanted it thicker, I have used two sheets, the press readily uniting them into one in the act of printing. This paper can be bought in bundles from the Senefelder Litho Stone Co., 32 Greene Street, and from the Fuchs & Lang Mfg. Company, 119 West Fortieth Street, both in New York City, and probably also from other similar concerns.

Engaging Japanese papers have at times been offered by the Japan Paper Co., mostly handmade and of world-wide repute as to beauty and strength. I have used them, more or less (there is sometimes uncertainty about replenishing one's supply), and often they have yielded fine proofs. Occasionally there has been trouble from long fibers pulling up on the surface, but I cure this by thinning the ink and using the paper dryer.

Many of our ordinary "bond" and "ledger" papers, particularly those of high quality and light weight, if properly damped, take lovely impressions. The objection is that they are cold and inartistic in color, and also that their excess of size disposes the print to cockle like a dried autumn leaf.

Once I happened on a paper that, while attractive to look at and even pulling a fine proof, had some chemical peculiarity of surface which so affected the stone as to render it shortly incapable of yielding any more fine prints.

On the whole, at the moment, for an amateur who wants to start with a single reliable well-looking paper that will work for him best and demand from him the least, I would suggest Basingwerk Parchment, 60 pounds to the ream.

There exist certain oriental papers, not here discussed, which, though beautiful, contain—so far as one can trust the evidence of his senses—no size whatever. Hence, they are so tender, when dampened, that the fibers stick ruinously to the ink, unless extreme sacrifices be made of the stiffness thereof, in which case it is just possible for an expert to work off a small edition. But they would merely madden an amateur.

All papers should be of the "wove" and not of the "laid" variety.

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wholly replaced [in common commercial practice, that is] by a paper made in imitation of it, but in every respect inferior."

COLOR OF PAPER

Any paper of a color much outside a mitigated white or an approximately neutral gray does not, as it should do, combine with a print in black, or approximately black, ink to form a true or approximately true monochromatic picture. Beautiful prints are pulled on gray-toned India insets on lighter plate paper, the gray India harmonizing with the hue of the ink and holding down the light from extravagant brilliancy injurious to atmosphere.

The beauty of such prints, however, is not to be supposed to depend on the grayness and the blackness, respectively, of the paper and the ink, but upon the fact that gray and black are true notes in a monochromatic scale—the lighter is the true natural light for the darker and the darker the true dark for the lighter.

The normally monochromatic art of drawing with crayon is not changed into something else by the fact of being executed upon stone. And in any monochromatic art the lights are the color that the darks would be if more light fell upon them. Black and white, however, are not the only colors possible to a true monochrome: theoretically, any color may furnish the basis for a monochrome. Practically, for aesthetic reasons, only a few delicate, warmish tones are seriously to be considered.

An ink not hot brown, like coffee—nor snuffy—but just a little removed from black in the direction of orange, which removal may be accomplished by adding a very little pure dry cadmium orange (with or without a trace of dry Indian red added to it) is very pleasant; and if a paper can be found which is the true lighter note of this tint, a lithograph perfectly monochromatic and more sensuously pleasant than a pure white and black one may be printed.

MY PASTURE

Size: 12¾ × 9 inches.
Serial number of stone: 343.
Crayon number: 420; made thus:

Carnauba wax	680 grains
Castile soap	350 grains
Palm-oil	10 grains
Lampblack	20 grains

Owing to the small quantity of pigment, the mark of this crayon is not black but of the value of red chalk. Before etching, the work was treated with an alkalinized gum, causing a rich roll-up.

LANDSCAPE

(Painting under Water)

Size: 24×16; Indoor.

Small number of stones: 3pc.

Crayon number: 308; made glue:

Stearine	1,100 grains
Mineral oil	150 grains
Lampblack	160 grains
Bobbet's Concentrated Lye (saturated solution)	270 drops

Hardness of crayon: about a No. 3.

"I transcribe from my notes: 'I filled it a lit. . . . Applied a little grain sluiced most of it off. Built up with warbour. Let dry. Re-wet and re-roller, getting Derelore, a heavy blue pewter tint. Finished 1-25."

In the tables of crayons I give there are many marked "insoluble." Any of them would act the same as this, so far as working in water was concerned. This print was made under as a technical experiment. Very few pails.

XII. EPILOGUE

° ° ° °

IN WRITING this book my business is to make you see lithography's *possibilities*. That is what excites me—not what has been, however fine, but what might be. This is what makes me a missionary. Through the ten years when I was making them, my lithographs were to me a series of explorations of these possibilities. Knowing so thoroughly the physical facts, creative imagination would all the time be crying aloud of the splendid things that their proved existence made certainly possible. I tried.

But my message today, as all along, is to other artists. What I haven't done and couldn't do is, of course, simply infinity. Nevertheless, my work certainly goes far enough in the New Lithography to show to inside students of it that here is an art of which we have but touched the hem of the garment.

All through the ten years I served, I was haunted by a vision and hope of many artists, widely various, making rewarding use of this art, enriching the world and having a lot of fun all at once. I know that various artists have done this and that, in a mild way, but speaking largely, Bellows is the only one who has taken it up wholeheartedly and shown something of what it can do. I mean, besides myself. The resources of the thing, as a method, are most fully demonstrated in my own prints, taken as a total, not in any one print. The time will come when many men will each make fine prints in every one of these ways. It must come, but probably not in my day.

I have peddled it, written it, exhibited it, hawked it and talked it, lectured it, "demonstrated" it, and done it. Wherewith, I make my bow.

APPENDIX

STEPS IN MAKING A LITHOGRAPH

1. Grain the stone
2. Wash the stone thoroughly
3. Round and polish the edges
4. Wash thoroughly again
5. Lay out picture rectangle
6. Draw edge of rectangle with lithographic line
7. Coat border outside rectangle with gum
8. Dry the gum
9. Draw the design
10. Coat stone with gum, with or without a trace of acid

Alternatives:

11.
    - *a*) Wash out crayon with solvent (turps, etc.) while gum is wet
    - *b*) Dry first, then wash out
    - *c*) Dry and leave dry

Alternatives:

12.
    - *a*) If freshly washed out in wet gum, thin gum and roll up
    - *b*) If dried, wash off gum and roll up
13. Sluice the rolled-up work with water free from gum
14. Dry the stone
15. Apply resin, etc., to protect work from acid
16. Measure stone's area
17. Mix etch to correspond
18. Apply etch
19. Dry
20. Wait
21. Wash off gum

Alternatives:

22.
    - *a*) Roll on the wetted stone as it is
    - *b*) Wash work off the wetted stone (with turps, etc.) and roll up
23. Lay on damp printing paper
24. Lay on this, dry soft backing paper
25. Lay on this, cardboard
26. Lay on this, the tympan
27. Roll table of press till scraper is over border of stone
28. Throw down lever
29. Turn screw controlling scraper till scraper bears firmly on stone
30. Throw back the lever
31. Turn screw controlling scraper about one-half to three-quarters of a revolution
32. Throw down lever
33. Turn handle till drawing has passed under the scraper but scraper still rests on stone. Never run the stone completely out from the scraper *while the pressure is on*
34. Throw up the lever
35. Draw the table of the press back to its first position
36. Lift off tympan and cardboard
37. Slowly lift off backing piece and print, together

Lithography is a delicate process and requires in its working the best of everything.

—David Cummings

LIST OF MATERIALS

STONES

First-class gray, one to ten according to needs. Not smaller than 10×12 inches or larger than 16×24 inches. Size 14×18 inches serves many purposes well. (Senefelder Litho Stone Co., 32 Greene Street, New York City.) One or two small pieces of the same, 3–6 inches, to be used for graining.

GRAINING MATERIALS

Sand. This is numbered from 60 to 120 corresponding to the mesh per inch of the sieve used. I use carborundum powder. It works much faster and gives a sharp grain. (The Carborundum Co., 13 Laight Street, New York City.) Comes in cans, ½–5 pounds. Get

1-pound can No. 150
1-pound can No. 180
1-pound can No. 220
1-pound can No. F
1-pound can No. FF

The numbers do not indicate the same grade as when used for sand. Roughly, 120 sand gives a grain more like 220 with carborundum.

Rasp for rounding stone's edge.
Chunk of genuine volcanic pumice stone.
Piece of Water-of-Ayr stone.
1 or 2 wooden or fiber pails for water.
1 or 2 glasses to dip water with.
1 large bowl to hold damping water.
Levigator, about 10 inches in diameter. (Stones may be substituted; see text.)
Graining stand. (See text.)

DRAWING MATERIALS

Carpenter's square.
Charcoal.
Lead pencils.
¼ lb. dry powdered Venetian red or red lead.
Sheets of thin paper for tracing—not waxy or oily.
Crayons. (See text.)
Slab for protecting stone from hand. (See text.)
Clean handkerchief.
Cotton batting, to dust stone off with.
Knife.
Scraper (knife does just as well).

Fine water-color brushes for ink accents.
Stumps of leather.
Chamois skin for rubbing.
Needle (steel point for picking).
Lithographic steel pen, if desired, to give ink accents.
Palm-leaf fan.
Drawing table. (See text.)

CRAYON-MAKING

1 lb. carnauba wax.
1 lb. Castile soap.
¼ lb. paraffin.
4 oz. mineral oil.
¼ lb. palm-oil.
1 lb. can Babbitt's Concentrated Lye.
1 sheet-iron frying pan, 5 inches in diameter.
1 table fork for stirring.
1 scales. (See text.)

PRINTING

1 stone slab to mix ink on.
1 ink knife (spatula); should be extra stiff in the tip.
1 scraper (like a putty knife).
1 best Schmalz hand roller, size to suit. (See text.)
1 pair leather handles for roller.
1 lb. best crayon litho ink. (See text.) Give preference to hardest.
1 pint can, each, Nos. 2, 3, 5, 6, and 7 of lithographic varnish. I use chiefly F. W. C. Carter's "Regular Burnt Litho Varnish," secured at 8 Ferry Street, New York.
2 lb. good gum arabic. Powdered is most convenient. (See text.)
1 oz. eugenol (preservative for gum solution).
1 one-pint fruit jar, to dissolve gum in.
1 wooden paddle to stir gum.
1 one-ounce druggist's graduate.
1 two-ounce druggist's graduate.
Medicine droppers, several, as near alike as possible.
1 pipette, carrying scale marking minims (Eimer and Amend, Eighteenth Street and Third Avenue, New York). Get rubber suction bulb with it.
Rags—clean, soft, preferably old linen and cotton.
Etching brush. Commercial houses use an expensive and thicker brush than is convenient for this technique. Brush should be 4 inches wide for large work, but 3

inches or less works for small ones. A good 3-inch soft-haired brush made of red pony hair (marked 1059/K. 6.) is sold for a dollar. Similar but smaller sizes, for less. The smallest size (1 inch wide) sells for 15 cents and is excellent for coating the edges of stones with gum. By Jap-Art Brush Co., New York.

1 piece of chalk.

2 good soft sheeps'-wool sponges.

1 qt. solvent naphtha—or spirits of turpentine.

½ pt. kerosene oil.

2 oz. linseed oil.

½ lb. hard tallow.

½ lb. genuine butter, without salt.

½ lb. lanolin.

1 screw press. A luxury, but not a necessity. To hold prints and to hold damp book.

1 damp book. (See text.)

Printing paper. (See text.)

Backing paper. (See text.) (50 sheets.)

Cardboard, 6-ply—2 sheets.

Blotting paper, white, 19×24 inches for ordinary work.

Red press board (tympan), No. 200. (Henry Lindenmeyr & Sons, 480 Canal Street, New York.)

Scraper leather, very best, i.e., most even in thickness.

Scrapers, very best, i.e., truly straight and without notches.

1 hand proving press, preferably geared. Size to suit proposed work. Small work can be done on a large press—large work cannot be done on a small one.

1 working apron or overalls.

1 box greasolvent, for washing hands.

FORMULAS FOR CRAYONS

SENEFELDER'S CRAYONS

	1	2	3	4	5	6	7	8
Wax	4	8	4	8	8	8	8	2
Soap	6	4	4	4	5	5	6	.....
Lampblack	2	2	2	2	3	3	3	2
Spermaceti	.....	.....	4	4	.....	.....	.....	.....
Shellac	.....	.....	.....	.....	4	4	.....	.....
Tallow	.....	.....	.....	.....	.....	2	4	6
Menniug	.....	.....	.....	.....	.....	.....	.....	2

Crayon which contains much shellac is likely to soften in damp air; therefore it should be kept in tightly closed vessels.

—Senefelder

ENGELMANN'S CRAYON

Yellow wax	640 grams
Tallow	80 grams
White soap	480 grams
Saltpeter (in 140 of water)	20 grams
Lampblack	140 grams

LEMERCIER'S CRAYONS

	Copal	1	2	3	4	Stumping
Yellow wax	500	500	500	500	500	250
Mutton tallow	60	50	50	70	70	340
Shellac	60	25	25	70	70	340
White soap	350	350	350	360	360	200
Copal	175	350	350	360	360	200
Saltpeter	15	15	15	15	15	200
Water	75	75	75	75	75	200
Bitumen of Judea	25	10	10	20	75	200
Lampblack	100	100	100	105	105	200

BURNINGS

Summer	10	8	6	4	3	.....
Winter	8 or 9	7	5	3	2	.....

"LONDON LITHO CHALK"

Beeswax	30
Tallow	25
Soap	20
Shellac	15
Black	6

Burn till hard enough.

"LITHO CRAYONS"

Beeswax	4
Tallow	3
White soap	13
Shellac	6
Black	3

Burn 1 minute before adding black.

BROWN'S CRAYONS

Various—selected from notebooks as examples.

Table A

(Insoluble)

Grade	5	4	3	2	1	0	00
Carnauba wax	29	18	13	13	18	18	18
White wax	.....	17	.....	.....	.....	.....	.....
Japan wax	.....	25	20	26	17	11	8
Tallow	.....	.....	.....	1	3	5	6
Paraffin	.....	.....	.....	1	.....	.....	.....
Vaseline	.....	2	2	2	.....	.....	.....
Mineral oil	.....	1	.....	1	9	14	16
Lampblack	14	14	13	13	13	12	12

Table B

(Insoluble)

Grade	5	4	3	2	1	0	00	000
Carnauba wax	50	45	40	35	30	25	20	18
Stearine	50	44	38	38	26	20	14	10
Mineral oil	.....	10	20	20	40	50	60	70
Paraffin	.....	.....	1	2	3	4	5	6

Table C

Grade	5	4	3	2	1	0	00
Carnauba wax	27	25	25½	26	26	24	23
White wax	19	.....	6	.....	.....	.....	.....
Japan wax	.....	18	16½	13	4	.....	.....
Tallow	.....	.....	.....	1	5	5	6
Vaseline	.....	1	1	2	.....	.....	.....
Paraffin	.....	.....	.....	.....	4	4	.....
Mineral oil	.....	3	3	5	9	17	19
Soap	14	13	13	13	13	12	19

Table D

Grade	6	5½	5	4½	4	3½	3	2½	2	1½	1
Stearine (grains)	990	952	911½	916½	1,036	983	1,130	1,088	1,045	1,005	96
Carnauba wax	200	136	72½	56½	41	30	18	18	18	18	18
White wax	12	11	10	9	8	7	6	5	4	3	2
Saturated solution of Babbitt's Concentrated Lye (drops)	228	219	210	211	238	226	260	250	239	231	222
Mineral oil	....	....	.....	20	25	60	85	126	167	293	420
Lampblack	150	149	148	147	146	145	144	143	142	141	140

TABLE E

(Crayons that transfer well; also work well on paper)

Grade	5	4	3	2	1	0
Carnauba wax	33	30	26	23	20	17
Japan wax	5	4	4	4	4	4
Palm-oil	4	6	6	6	.....	.....
Vaseline	.....	.....	.....	.....	6	6
Sweet oil	.....	.....	3	6	.....	.....
Mineral oil	.....	.....	.....	.....	9	12
Paraffin	2	3	4	4	4	4
Soap	17	17	17	17	17	17
Lampblack	10	10	10	10	10	10

TABLE F

(Crayons that roll and print darker than they draw, owing to the small amount of pigment in them. [Soluble])

Grade	5	4½	4	3½	3	2½	2	1½	1
Carnauba wax	600	570	547	520	496	468	442	330	441
Castile soap	600	570	547	520	494	468	442	330	.....
Mineral oil	.....	75	150	225	300	375	450	508	1,210
Lampblack	27	27	27	28	28	29	29	30	33
Stearine	.....	.....	.....	.....	.....	.....	.....	.....	176
Saturated solution of Babbitt's Concentrated Lye (drops)	.....	.....	.....	.....	.....	.....	.....	.....	58
Palm-oil	.....	.....	.....	.....	.....	.....	.....	.....	40

BROWN'S CRAYONS—*Continued*

Very hard, smooth-working crayons—results comparable to silverpoint and hard lead pencil.

X156
- Carnauba wax 96
- Stearine soap 24
- Black 12

X157
- Carnauba wax 90
- Stearine soap 30
- Black 12

X158
- Carnauba wax 30
- Stearine soap 30
- Black 6

X159
- Carnauba wax 20
- Stearine soap 40
- Black 6

X151
- Carnauba wax 70
- Stearine soap 30
- Palm-oil 20
- Black 12

X372 (low pigment; grade = about 5)
- Carnauba wax 250
- Castile soap 250
- Lampblack 4

X373 (about 5)
- Carnauba wax 80
- Castile soap 80
- Mineral oil 64
- Lampblack 24

X162 (about 5; insoluble)
- Carnauba wax 60
- Stearine soap 30
- Palm-oil 30
- Lampblack 12

X176 (about grade 4; insoluble, stands hard etch)
- Carnauba wax 47
- Chinese wax 30
- Stearine 13
- Soap 30
- Lampblack 14

X103 (grade 4)
- Carnauba wax 22
- Japan wax 32
- Paraffin 1
- Mineral oil 3
- Stearine soap 13

X201 (grade 2)
- Carnauba wax 23
- Paraffin 19
- Chinese wax 15
- Castile soap 28
- Mineral oil 30
- Palm-oil 5
- Black 12

X231 (grade 1; insoluble)
- Carnauba wax 20
- Stearine soap 30
- Paraffin 45
- Palm-oil 10
- Mineral oil 15
- Lampblack 10

X375 (grade 1; soluble)
- Carnauba wax 60
- Castile soap 60
- Mineral oil 144
- Lampblack 24

X252 (grade 00; insoluble)
- Stearine 60
- Mineral oil 60
- Black 12

X125 (grade 00)
- Carnauba wax 18
- Japan wax 7
- Tallow 6
- Mineral oil 16
- Soap 13

X100 (grade 3)
- Japan wax 27
- Carnauba wax 16
- Paraffin 2
- Mineral oil (drops) 6
- Soap 12

X115 (grade 3)
- Carnauba wax 13
- Japan wax 30
- Vaseline 4
- Soap 13

X202 (grade 3)
- Carnauba wax 34
- Chinese wax 23
- Paraffin 10
- Stearine 4
- Soap 32
- Mineral oil 15
- Palm-oil 2
- Black 12

X374 (grade 3)
- Carnauba wax 60
- Castile soap 60
- Mineral oil 96
- Black 24

X178 (grade 3½; excellent)
- Carnauba wax 40
- Chinese wax 32
- Stearine 3
- Palm-oil 5
- Castile soap 40
- Black 12

X404 (grade, medium; for new process)
- Carnauba wax 505
- Castile soap 475
- Palm-oil 12½
- Black 120

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